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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 189912

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.		4. Date
Supplemental [] Direct Revision [x] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	J. A. Locklair, Environmental Restoration Safety Support, H4-67, 6-4409		July 23, 1993
	5. Project Title/No./Work Order No. N/A	6. Bldg./Sys./Fac. No. N/A	7. Impact Level 2 ESQ
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-EN-SAD-016, Rev. 0, Vol.3	9. Related ECN No(s). N/A	10. Related PO No. N/A

11a. Modification Work	11b. Work Package No.	11c. Modification Work Complete	11d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 11b) [x] No (NA Blks. 11b, 11c, 11d)	N/A	N/A Cog. Engineer Signature & Date	N/A Cog. Engineer Signature & Date

12. Description of Change

Revisions reflect the well-casing perforating techniques considered and selected for perforation of existing wells. Appendix A provides an indepth explanation of the selected method and a work plan for safe conduct during operations. Appendix B includes information on the generation and attenuation of seismic energies resulting from the selected method. Appendix C provides an analysis of the soil column contaminant inventory of Well 299-W18-19.

13a. Justification (mark one)	Criteria Change []	Design Improvement []	Environmental [x]
As-Found []	Facilitate Const. []	Const. Error/Omission []	Design Error/Omission []

13b. Justification Details

See Block 12.

14. Distribution (include name, MSIN, and no. of copies)

See attached distribution sheet.

RELEASE STAMP

A-7900-013-2 (06/92) GEF095

A-7900-013-1 (06/92)

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 189912

15. Design Verification Required	16. Cost Impact				17. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]		[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

20. Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog Engineer L. C. Hulstrom *LC Hulstrom*	7/29/93	PE N/A	
Cog. Mgr. R. A. Carlson *RA Carlson*	7/29/93	QA N/A	
QA T. L. Bennington *TL Bennington*	7/28/93	Safety N/A	
Safety K. A. Smith *[signature]*	7/29/93	Design N/A	
Security N/A		Environ. N/A	
Environ. K. A. Gano *KA Gano*	7-27-93	Other	
Projects/Programs N/A		Env. Field Services D. J. Moak *DJ Moak*	7-29-93
Tank Waste Remediation System N/A			
Facilities Operations N/A		DEPARTMENT OF ENERGY	
Restoration & Remediation		Signature or Letter No.	
Operations & Support Services N/A			
IRM		ADDITIONAL	
Other			
SA&E N. R. Kerr *[signature]*	7/26/93		
SA&E J. J. Zimmer *[signature]*	7/26/93		

AUG 1993

A-7900-013-3 (06/92) GEF096

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RECORD OF REVISION

(1) Document Number: WHC-SD-EN-SAD-016, Vol. 3

Page

(2) Title
Safety Assessment for Environmental Investigations and Site Characterizations
Volume 3: Aggregate Safety Assessment for Installing Groundwater Monitoring Wells

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Rev. 0 released per EDT 159897 Rev. 0-A released per ECN 189912		
0-A	Replace Contents page; this page has been revised to reflect new page numbers and additions. Replace pages 14 to 28. Changes reflect the well-casing perforating techniques considered and selected for perforation of wells.	L. C. Hulstrom LC Hulstrom 7/29/93	R. A. Carlson RACarlson 7/29/93
0-A	Add Appendixes A, B, and C. Appendix A provides an indepth explanation of the selected perforation method and a work plan for safe operations. Appendix B includes information on the generation and attenuation of seismic energies resulting from the selected method. Appendix C provides an analysis of the soil column contaminant inventory of Well 299-W18-19.	L. C. Hulstrom LC Hulstrom 7/29/93	R. A. Carlson RACarlson 7/29/93

Date Received:	INFORMATION RELEASE REQUEST	Reference: WHC-CM-3-4

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WHC-SD-EN-SAD-016, Rev. 0-A, Vol. 3

List attachments.
Appendices A, B, and C

Date Release Required
July 30, 1993

Title Safety Assessment for Environmental Investigations and Site Characterizations - Vol. 3: Aggregate Safety Assessment for Installing Groundwater Monitoring Wells	Unclassified Category UC-	Impact Level 2 ESQ

New or novel (patentable) subject matter? [X] No [] Yes
If "Yes", has disclosure been submitted by WHC or other company?
[] No [] Yes Disclosure No(s).

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[X] No [] Yes (Identify) See attached list.

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CHECKLIST FOR SIGNATORIES

Review Required per WHC-CM-3-4	Yes	No	Reviewer - Signature Indicates Approval Name (printed)	Signature	Date
Classification/Unclassified Controlled Nuclear Information	[]	[X]			
Patent - General Counsel	[]	[X]	OGC Memo		
Legal - General Counsel	[]	[X]	OGC Memo		
Applied Technology/Export Controlled Information or International Program	[]	[X]			
WHC Program/Project	[]	[X]			
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Other Program/Project	[]	[X]			

Information conforms to all applicable requirements. The above information is certified to be correct.

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References Available to Intended Audience	[X]	[]
Transmit to DOE-HQ/Office of Scientific and Technical Information	[]	[X]

Author/Requestor (Printed/Signature) Date
J. A. Locklair J.A. Locklair

Intended Audience
[] Internal [] Sponsor [X] External

Responsible Manager (Printed/Signature) Date
N. R. Kerr NRK 7-30-93

INFORMATION RELEASE ADMINISTRATION APPROVAL STAMP
Stamp is required before release. Release is contingent upon resolution of mandatory comments.

Date Cancelled	Date Disapproved

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ID Number

Lead Author	Phone	MSIN	Other Author(s) or Requestor
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Mandatory Comments (Only mandatory comments are to be documented. All other comments should be made on a copy of the information submitted for review and returned to the author.)	Reviewer Name & Signature	Date	Resolution	Reviewer Name & Signature	Date

Legends/Notices/Markings (required per WHC-CM-3-4 or guidance organization.) (Reviewer initials)

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Patent Status	[ ]	[x]			

N. R. Kerr
Responsible Manager (Printed/Signature)

SUPPORTING DOCUMENT

1. Total Pages 31	

2. Title	3. Number	4. Rev No.
Safety Assessment for Environmental Investigations and Site Characterizations Volume 3: Aggregate Safety Assessment for Installing Groundwater Monitoring Wells	WHC-SD-EN-SAD-016 Volume 3	0-A

5. Key Words	6. Author
Safety Assessment Groundwater Monitoring Wells Abandonment/Decommissioning Groundwater Contamination	Name: J. A. Locklair J. A. Locklair Signature Organization/Charge Code 29550/PLBAH

7. Abstract

This safety assessment addresses the installation, development, sampling, remediation, and abandonment of groundwater monitoring wells and accesses the adequacy of existing work procedures.

8. PURPOSE AND USE OF DOCUMENT - This document was prepared for use within the U.S. Department of Energy and its contractors. It is to be used only to perform, direct, or integrate work under U.S. Department of Energy contracts. This document is not approved for public release until reviewed.

PATENT STATUS - This document copy, since it is transmitted in advance of patent clearance, is made available in confidence solely for use in performance of work under contracts with the U.S. Department of Energy. This document is not to be published nor its contents otherwise disseminated or used for purposes other than specified above before patent approval for such release or use has been secured, upon request, from the Patent Counsel, U.S. Department of Energy Field Office, Richland, WA.

9. Impact Level 2 ESQ

10. RELEASE STAMP

CONTENTS

APPENDIXES

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CONTENTS (cont.)

TABLES

FIGURES

3. Withdraw the well from use when the following apply to the well:

   a. Not suitable for rehabilitation or has failed structurally
   b. Not chemically compatible with its environment
   c. No longer required for any documented use
   d. Cannot meet data quality objectives for the well.

Wells will be abandoned to meet Washington State regulations for well abandonment and Hanford Site requirements for public health and environmental protection and waste minimization.

There were three techniques considered for perforation of existing abandoned wells: Mills Knife[3], PerfHawk[4], and Jet Shot[5]. The first two methods have been used successfully on single-casing drill strings. The Jet Shot system is the preferred technique for double-casing drill strings, as the Mills Knife and PerfHawk systems cannot assure complete perforation of double-casings. The Jet Shot technique is used within the oil and groundwater well communities and is commonly accepted by both industries.

The Jet Shot system uses Class C explosives to induce a vaporization of the adjacent casing (Appendix A provides an indepth explanation of the methodology). It is anticipated that 3 to 20 grams of Class C explosives will be used for each Jet Shot perforation event; the generation and attenuation of resulting seismic energies are discussed in Appendix B. The energies caused by the use of this system are not anticipated to induce sufficient seismic influence to cause concern.

Jet Shot shall only be used in subsurface zones free of radiological and/or chemical contaminants. Any planned uses of this technique on subsurface radiological or chemical plumes will require additional evaluation (as required by WHC-CM-4-46) and approval from appropriate safety functions. Compliance with applicable regulatory criteria are discussed in Appendix B to assure a safe envelope of operation. Institutional controls such as the JSA, HWOP, RWP, and adherence to vendor safety plans for conduct on job sites (Appendix A) will also be followed.

Appendix B contains a plan for decommissioning and abandonment of Well 299-W18-19 using the Jet Shot system. This plan provides steps for complying with WAC 173-160-415 for well abandonment at the Hanford Site. Other wells where this perforation system will be used may be slightly different in depth or diameter but the concept is essentially the same. Appendix C provides an analysis of the Well 299-W18-19 soil column contaminant inventory.

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[3]Mills Knife is a registered trademark of Mitchell, Lewis & Staver Co., Wilsonville, Oregon.

[4]PerfHawk is a registered trademark of Hawk Industries, Inc., Long Beach, California.

[5]Jet Shot is a registered trademark of Cogco, Inc., Woodland, California.

2.12 POTENTIAL ENERGIES

Potential energies were evaluated to determine the level of impact, if any, on the intrinsic hazards introduced in Section 2.1. The potential energies are listed below:

- Advancement of the drill bit in the borehole
- Compressed air employed in the Odex method
- Ignition of combustible gas originating from the borehole
- Work done by the pump to extract purgewater
- Energy imparted to contaminant particulates by wind.

Advancement of the drill bit through the vadose zone does not provide a mechanism for dispersement of potentially contaminated soils except when the cuttings are removed from the borehole. The removal of drill cuttings is performed in accordance with WHC-CM-7-7 (EII 4.2).

The use of compressed air as a circulation media in the Odex drill method does provide a means for lofting potentially contaminated particulate into the air. A containment system (TORIT[6] fan-filter combination) is currently employed with the Odex method and has proven to be an effective method for controlling fugitive dust. Nevertheless, the Odex method is now used only where there are no known contaminants in the soils. Consequently, compressed air is not an issue because there are no hazardous materials present. In the event that the Odex method is used at contaminated sites in the future, the compressed air and containment system must be reevaluated.

Low levels of combustible gases may be encountered in the borehole during drilling operations, thus presenting a potential flammable hazard if cutting or welding on the well casing is performed. Many groundwater wells have been installed on the Hanford Site to date. Results from past drilling experience indicate that the advancement of the drill bit through the vadose zone has no significant impact on combustible gases.

Work done by the pump in conducting purgewater from the aquifer to the surface does not increase the inherent hazard of contaminated purgewater (discussed in Section 4.1).

Wind has a potential for unsettling and spreading potentially contaminated dust. Given the unstable air conditions in the field, the small fraction of respirable size particles, and the characteristic low level contamination, an airborne radionuclide hazard to the site worker is unlikely. A conservative worst case accident scenario involving contaminated drill cuttings was analyzed in Lehrschall 1992. A discussion of the accident scenario is covered in Section 4.0 of this document.

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[6]TORIT is a registered trademark of TORIT Manufacturing Company, St. Paul, Minnesota.

3.0 SITE DESCRIPTIONS

3.1 PHYSICAL SETTING

The Hanford Site is located in south-central Washington State, approximately 273 km (170 mi) southeast of Seattle and 201 km (125 mi) southwest of Spokane (Figure 5). The average annual precipitation at the Hanford Site is 16.1 cm (6.3 in.). Most of the precipitation takes place during the winter, with nearly half of the annual amount occurring from November through February (Delaney et al. 1991). Average monthly temperatures at the Hanford Site range from 1.5° C (29° F) in January to 24.7° C (76° F) in July (PNL 1990).

3.2 METEOROLOGY

Prevailing wind directions are generally from the northwest throughout the year. Winds from the northwest quadrant occur most often during the winter and summer. During the spring and fall, the frequency of southwesterly winds increases. Monthly average wind speeds are generally lowest during the winter, averaging 10 to 11 km/hour (6.2 to 6.8 mi/hour). Monthly average wind speeds that peak above average are usually associated with southwesterly winds (PNL 1990).

3.3 GEOLOGY

The Hanford Site lies near the center of the Pasco Basin, a sub-basin of the Columbia Basin. Bedrock in the Pasco Basin is the Columbia River Basalt Group, which consists of numerous basalt flows and interbedded sediments with maximum accumulations of more than 3,048 m (10,000 ft).

Overlying the Columbia River Basalt Group at the Hanford Site are unconsolidated deposits ranging in thickness from 0 to 182.88 m (0 to 600 ft). The major unconsolidated deposits include the Ringold Formation, a thick fluvial/flood plain sequence of gravel, sands, silts and clays, and the Hanford Site formation, a glacial fluvial deposit of coarse-grained gravel and sand. A generalized geologic cross section of the Hanford Site is shown in Figure 6.

Figure 5. Orientation of the Hanford Site.

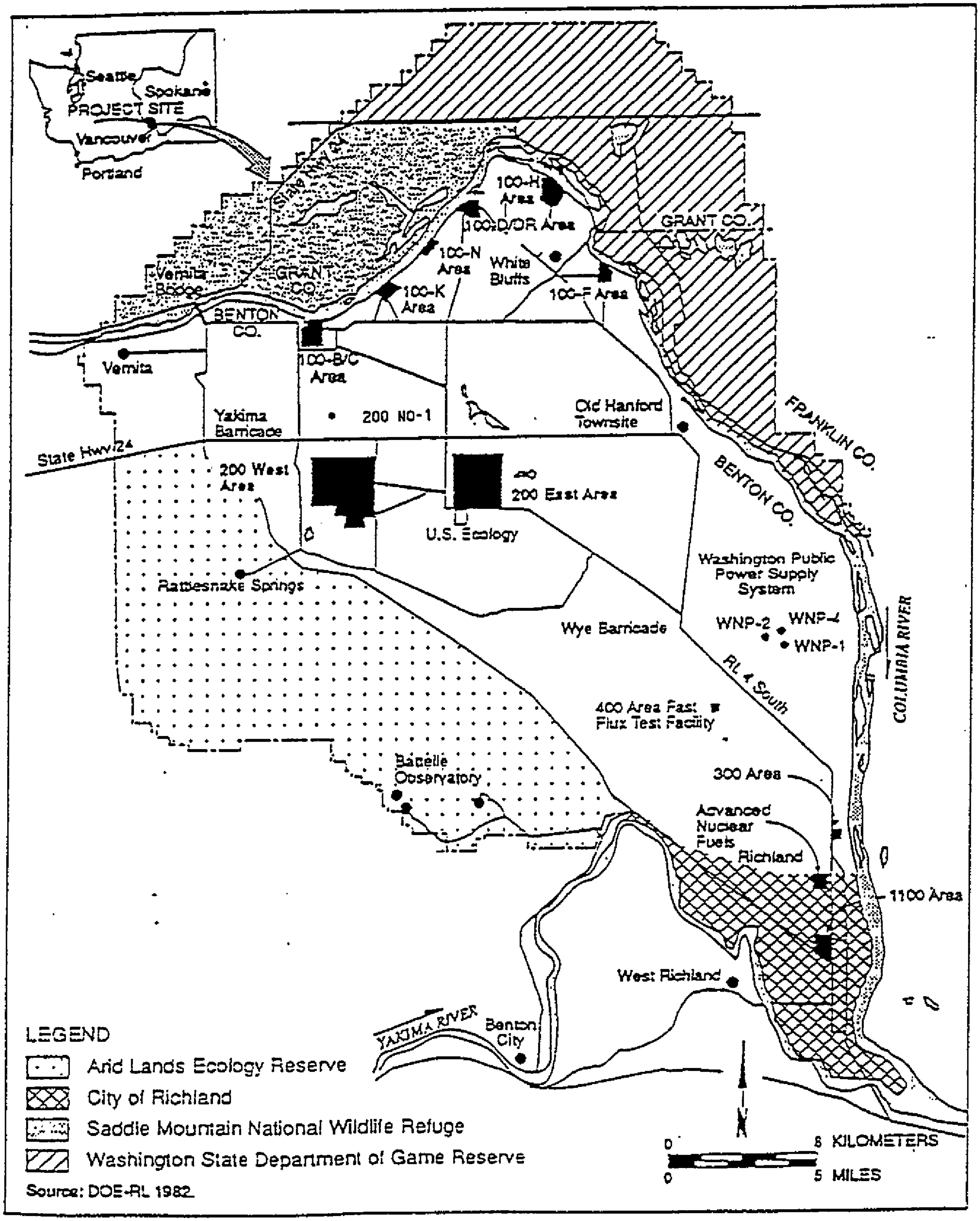

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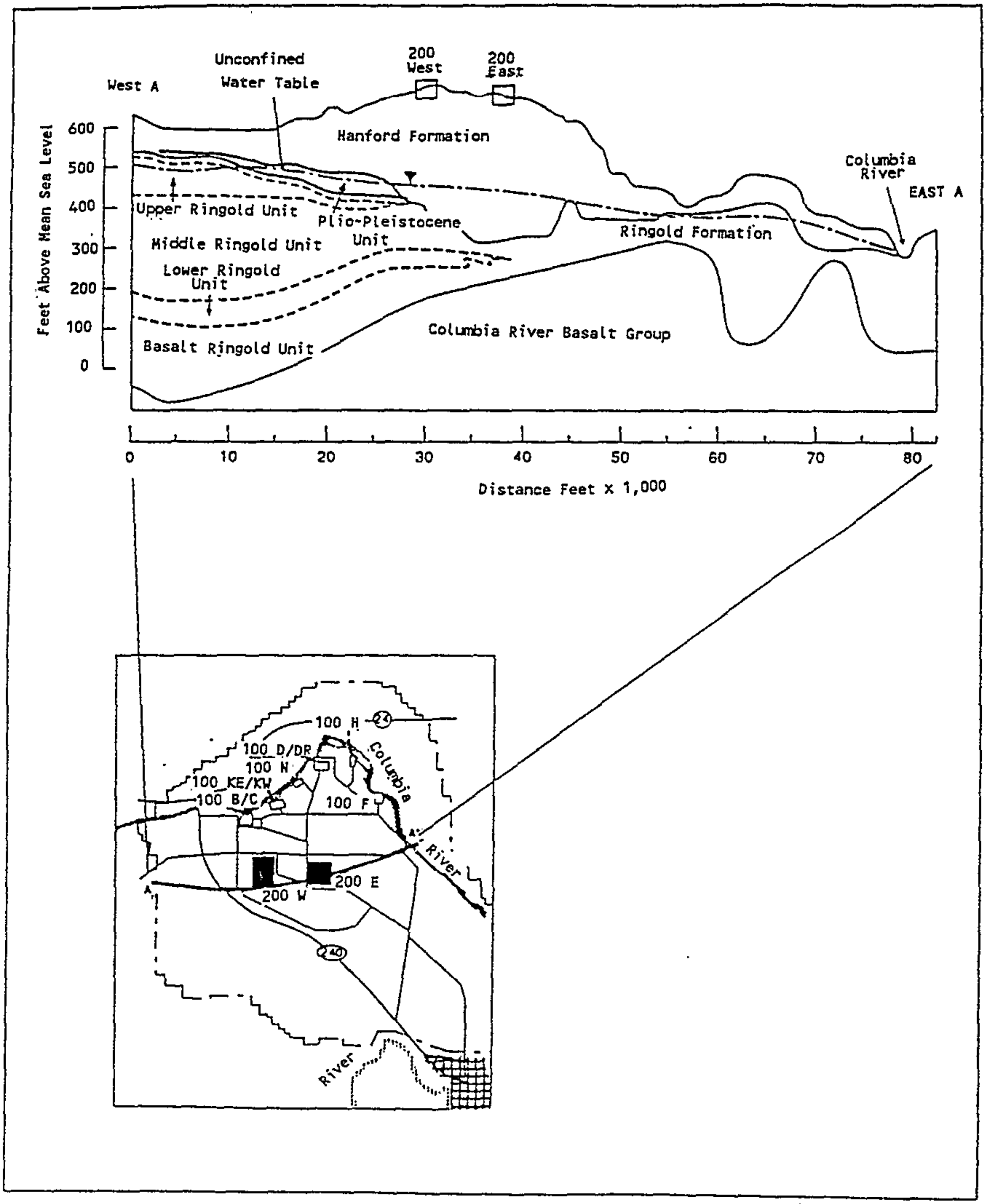
Figure 6. Generalized Cross Section of the Hanford Site.



Source: Liikala et al. 1988

3.4 HYDROGEOLOGY

Groundwater at the Hanford Site occurs under both confined and unconfined conditions. The unconfined aquifer is contained primarily within sedimentary deposits of the Ringold and Hanford Site formations. The depth to groundwater beneath the plateau area of the Hanford Site is generally 61 (200 ft) to 91 m (300 ft). North and east of Gable Butte in the 100 Areas, however, the water table is shallower and lies within the Hanford Site formation at depths as shallow as 6.7 m (22 ft) from ground surface (Liikala et al. 1988). The base of the unconfined aquifer is defined either by the clay zones of the lower Ringold Formation or by the top of Columbia River Basalts where the lower Ringold Formation is absent. A map of recent water table elevations at the Hanford Site can be seen in Figure 7.

Groundwater generally moves eastward across the Hanford Site and north to northeast beneath the 100 Areas towards the Columbia River, which receives groundwater discharge from the unconfined aquifer along much of its length. The general eastward flow is interrupted by groundwater mounds that occur near the 200 Areas as a result of artificial recharge from onsite disposal of process water.

The unconfined aquifer is naturally recharged by precipitation, infiltration from higher elevations, leakage from the confined aquifer, and influent reaches of the Yakima and Columbia Rivers. Most of this recharge originates from higher elevations in Cold Creek and Dry Creek Valleys, immediately west of the Hanford Site.

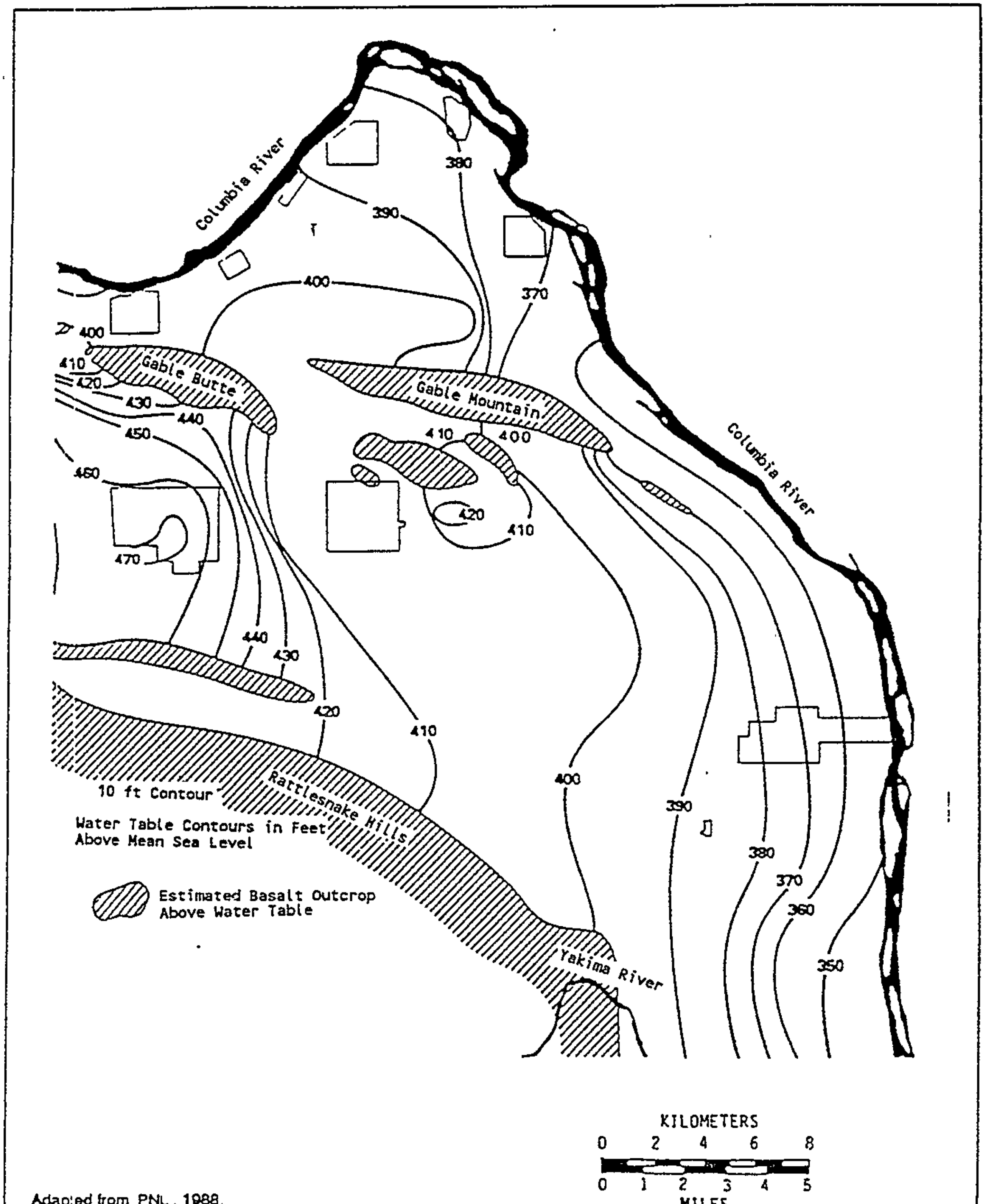
The confined aquifers of the regional groundwater flow system are contained in the rubbley interflow zones within the basalts and in sedimentary units interbedded within the Columbia River Basalt Group.

4.0 HAZARDS ASSESSMENT

4.1 DISCUSSION AND SUMMARY OF POTENTIAL HAZARDS

The potential exposure pathways for hazardous substances encountered during the groundwater drilling and sampling activities may consist of inhalation, ingestion, or absorption. The hazardous materials consist of potentially contaminated drill cuttings, contaminated groundwater, and potential hazardous concentrations of volatile organic compounds. Section 2.1 shows that contamination levels encountered during groundwater well drilling activities are relatively low. Because of the low contamination levels, air concentrations of suspended contaminants at the drill site are anticipated to be orders of magnitude below the derived air concentrations (DAC) for the potential radionuclides in the drill cuttings. Maximum radiological contamination is anticipated to be less than 10,000 dpm beta\gamma per probe area measured with field instruments.

Figure 7. Recent (1987) Water Table Elevations at the Hanford Site.



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Inhalation of dust generated from the drilling activity, though unlikely, is the principle pathway by which a worker might be internally exposed to radionuclides. For estimating a worst case dose consequence for groundwater well drilling, a 10 mR/hour contact reading on the drive barrel is assumed and the contents dropped to the ground. The estimated dose consequences to the three receptors are then 0.14 mrem to the site worker, 0.062 mrem to the onsite, and 4.6 E-5 mrem to the offsite individual. The results are summarized and compared to the low hazard class limits in Table 2 below.

Table 2. Dose Consequences and Corresponding Limits.

Receptor	Dose consequence (rem)	Hazard class limit (rem)
Site worker	1.4 E-4	25
Onsite worker	6.2 E-5	5
Offsite individual	4.6 E-8	0.5

A potential exists for organic vapors to collect at the well head as a result of drilling through an underground plume (such as the CCl_4 plume in the 200 West Area) and into contaminated groundwater. Air concentrations at the well head have been known to exceed the 2 p/m 8-hour time weighted average (TWA) for CCl_4 on occasion. There are no hazard class criteria for toxicological consequences to the site worker. A general use classification for activities where the consequence to an onsite individual is <0.1 immediately dangerous to life or health (IDLH) is provided in WHC-CM-6-32, *Safety Analysis and Regulation Work Procedures*. Carbon tetrachloride has an IDLH of 300 p/m; one tenth of the IDLH is 30 p/m. Concentrations of this magnitude are highly unlikely to the onsite receptor [generally located at 100 m (330 ft)]. The *Code of Federal Regulations* sets the acceptable ceiling limit at 25 p/m for CCl_4 (29 CFR 1910, Table Z-2). The Site Safety Officer and Field Team Leader are responsible for providing the proper respirator protection for personnel at the drill site if breathing zone air concentrations exceed occupational limits.

Skin contamination is a minor concern to the site worker performing the drilling and sampling activities where drill cuttings and groundwater are found to be contaminated. The EIIs listed in Table 1, along with the JSA, RWP, and HWOP provide the appropriate procedures and protective clothing requirements for preventing skin contaminations.

The contaminants of concern for the Hanford Site groundwater vary somewhat depending on the location of the monitoring well installation. Table 3 provides a listing of the contaminants of concern in groundwater at each area with the corresponding concentrations and the collection limits that determine whether the purgewater is collected and stored or simply discharged at a convenient distance away from the well site. According to DOE-RL 1990 (Section 3.1.1), purgewater collection criteria is based on 10 times the MCL for drinking water, or 10 times the EPA's "Chronic Freshwater Toxicity Levels," or 10 times the practical quantitation limits provided in the *Test Method for Evaluating Solid Waste--Physical/Chemical Methods* (EPA 1986) with the application of the most restrictive criteria for designation of purgewater requiring collection. The radionuclide standards are based on 10 times the MCLs referenced in 40 CFR 141 [see also 40 CFR 141.16(b)] except for uranium and plutonium standards that are based on 10 times 1/25th of the derived concentration guides as defined in DOE Order 5400.5 (DOE 1990). Tritium is not included in purgewater determinations because effective treatment technology has not been demonstrated. Disposal to the soil is a less hazardous pathway to biota than storing tritium contaminated water above ground that would involve a larger airborne pathway (DOE-RL 1990).

Table 3 indicates that some of the contaminants exceed the collection criteria. These limits are conservative in regard to public health and safety and do not represent acute exposure limits. The purgewater management document (DOE-RL 1990) and WHC-CM-7-7 (EII 10.3) are adequate for providing the necessary controls for generating and disposing of purgewater. The hazard associated with the purgewater is an ALARA issue and represents only a minor concern to the site worker. There are no impacts to the onsite worker or the public.

A safety assessment was performed for the purgewater storage facility (Erb 1991) that is located east of the 200 East Area fence line at the Hanford Site. Loss of containment due to a severe seismic event where 5,000,000 gal is released was the bounding postulated release. It was concluded in the assessment that loss of containment may result in exceeding environmental discharge limits to the groundwater but doses to onsite or offsite receptors would be negligible. The CCl_4 present in the purgewater was determined to pose no threat to onsite or offsite personnel. Doses to operations personnel based on a tritium intake (tritium is the major radiological component) was conservatively estimated at one mrem. The assessment concluded that CCl_4 vapor could possibly exceed the threshold limit value TWA but based on a noncontinuous exposure, the risk to the onsite worker is negligible.

4.2 DISMISSAL OF NEGLIGIBLE HAZARDS

4.2.1 CRITICALITY

A criticality event was dismissed based upon the lack of sufficient fissionable material at locations where groundwater monitoring wells are installed.

4.2.2 RADON GAS

Radon gas emissions were evaluated in the assessment for drilling in relatively high contaminated soils and were found to be negligible (Lehrschall 1992).

Table 3. Contaminants of Concern and Collection Criteria.

Area	Contaminant	Concentration	Collection Criteria
100-BC	Strontium-90	50 pCi/L	80 pCi/L
--	Cesium-137	20 pCi/L	2,000 pCi/L
--	Chromium	0.05 mg/L	0.11 mg/L
--	Nitrate	50 mg/L	450 mg/L
100-K	Nitrate	60 mg/L	450 mg/L
--	Tritium	500,000 pCi/L	N/A
--	Chromium	0.12 mg/L	0.11 mg/L
100-N	Strontium-90	10,000 pCi/L	80 pCi/L
--	Tritium	100,000 pCi/L	N/A
100-D	Strontium-90	40 pCi/L	80 pCi/L
--	Tritium	30,000 pCi/L	N/A
--	Chromium	0.5 mg/L	0.11 mg/L
--	Nitrate	100 mg/L	450 mg/L
100-H	Nitrate	200 mg/L	450 mg/L
--	Chromium	0.3 mg/L	0.11 mg/L
--	Technetium-99	2,000 pCi/L	9,000 pCi/L
--	Uranium	100 pCi/L	400 pCi/L
100-F	Strontium-90	200 pCi/L	80 pCi/L
--	Uranium	80 pCi/L	400 pCi/L
--	Nitrate	120 mg/L	450 mg/L
300	Uranium	270 pCi/L	400 pCi/L
--	Gross beta	40 pCi/L	500 pCi/L
--	Tetrachloroethane 1,2 Dichloroethene	0.02 mg/L 0.15 mg/L	8.4 mg/L
--	Copper	0.04 mg/L	0.12 mg/L
1100	Trichloroethylene	0.06 mg/L	0.05 mg/L
--	Gross Beta	30 pCi/L	500 pCi/L
--	Nitrate	200 mg/L	450 mg/L
200 East	Nitrate	300 mg/L	450 mg/L
--	Technetium-99	10,000 pCi/L	9,000 pCi/L
--	Cyanide	500 µg/L	0.052 mg/L
--	Cobalt-60	500 pCi/L	1,000 pCi/L
--	Strontium-90	5,000 pCi/L	80 pCi/L
--	Cesium-137	2,000 pCi/L	2,000 pCi/L
--	Plutonium	70 pCi/L	12 pCi/L
--	Iodine-129	10 pCi/L	30 pCi/L
--	Tritium	2,000,000 pCi/L	N/A
200 West	Carbon tetrachloride	1.0 mg/L	0.05 mg/L
--	Chloroform	0.20 mg/L	1.0 mg/L
--	Cyanide	0.050 mg/L	0.052 mg/L
--	Chromium	0.050 mg/L	0.11 mg/L
--	Technetium-99	10,000 pCi/L	9,000 pCi/L
--	Uranium	5,000 pCi/L	400 pCi/L
--	Nitrate	500 mg/L	450 mg/L
--	Tritium	200,000 pCi/L	N/A
--	Iodine-129	10 pCi/L	30 pCi/L
600	Tritium	200,000 pCi/L	N/A

N/A = Not applicable

4.2.3 NATURAL PHENOMENA

Natural phenomena events such as floods, runoff, lightning, and earthquakes would not have any appreciable impact as far as increasing the hazardous material consequences considered in this assessment. A natural phenomenon like lightning may be a hazard in and of itself and therefore may have an influence on the type of weather conditions allowed when drilling. High wind events could potentially contribute to the spread of minor soil contamination from well drilling activities. Compliance with the procedures contained in WHC-CM-7-7 will assure that contamination spreads do not occur.

4.3 CONCLUSION

This assessment concludes that groundwater well drilling activities performed in areas that exceed the criteria specified in WHC-CM-4-10 (Table 11-1) are classified as low hazard activities in accordance with the policy requirements of WHC-CM-4-46 and the work procedures of WHC-CM-6-32. Activities performed in areas that are below the surface radioactivity guides specified in WHC-CM-4-10 (Table 11-1) are classed as general use and are excluded from the safety analysis and review requirements of DOE 1986 and do not require an OSL. This safety assessment satisfies the requirements of WHC-CM-4-46 and DOE 1986.

An OSL addressing the maximum field dose rates on drill cuttings is provided in Section 5.0. The OSL was prepared to assure the integrity of the safety basis established in this assessment.

Potentially combustible gases may be encountered that present a potential fire hazard to workers if accidentally ignited. An OSL was prepared that puts a limit on the levels of combustible gases in the borehole when spark producing activities are performed.

5.0 OPERATIONAL SAFETY LIMITS AND PRUDENT ACTIONS

An OSL is an auditable limit established within WHC for the safe operation of a nonreactor nuclear facility or activity. The RL has a policy that at least one limit shall be established to assure the facility is operated or activity is performed safely and within the bounds of the safety assessment. Site or activity specific RWPs, HWOPs, or other safety documents shall implement the appropriate OSL(s). The limits may be more stringently specified commensurate with the site conditions but shall not exceed the bounds of the OSL.

Two OSLs were prepared to ensure the integrity of the safety basis of this assessment. The first OSL sets a limit of 10 mR/hour on the drill cuttings at wells drilled or remediated in areas where the criteria of WHC-CM-4-10 (Section 11) is exceeded. The second OSL limits spark producing activities when combustible gas levels >10% of the LEL are detected in the borehole.

Other groundwater activities such as development, sampling, and abandonment of groundwater monitoring wells will be excluded from the OSL requirement. Hazards and risks are such that existing procedures contained in WHC-CM-7-7 are sufficient for providing adequate controls.

5.1 OPERATIONAL SAFETY LIMITS

<u>OPERATIONAL SAFETY LIMIT 1 - CONTROLLING RADIOACTIVITY ENCOUNTERED DURING ACTIVITIES</u>

1.1 TITLE: Limit the Potential Radioactivity of the Soils Removed from the Borehole.

1.2 APPLICABILITY This OSL applies to the drilling or remediation of groundwater wells where the criteria specified in WHC-CM-4-10 (Section 11) is exceeded.

1.3 OBJECTIVE: To provide a measure of control on the radioactivity encountered during drilling and remediation activities.

1.4 REQUIREMENT: Dose rates on the drill cuttings removed from the bore hole shall not exceed 10 mR/hour on contact.

1.5 SURVEILLANCE: Drill cuttings generated from well drilling or remediation shall be monitored at a frequency that is to be determined on a case-by-case basis. The field team leader, in conjunction with the Site Safety Officer, and health physics technician, will increase the frequency of the surveillance if the potential of encountering contamination increases. Compliance with the requirement in 1.3 above shall be documented in an auditable log or Field Activity Report.

1.6 RECOVERY: In the event that the OSL is exceeded, the work shall stop. The source of the unanticipated contamination levels shall be evaluated and a recovery plan prepared. Safety Assurance will provide the oversight approval prior to implementation of the recovery plan.

1.7 BASIS: The limit provides assurance that the integrity of the safety basis established in this assessment is maintained. Existing and approved work procedures would accept higher limits based on occupational safety. The recovery work plan, if required, will assure that if unanticipated conditions (radiological) are encountered the conditions will be assessed to minimize the potential of unknown risks.

OPERATIONAL SAFETY LIMIT 2 - LIMITS FOR SPARK PRODUCING ACTIVITIES

2.1 TITLE: Limits for spark producing activities (i.e., welding, cutting, and grinding) when combustible gases are detected.

2.2 APPLICABILITY: This OSL applies to all spark producing activities when combustible gases ≥10% of the LEL are detected in the borehole.

2.3 OBJECTIVE: To assure that combustible gas levels are reduced below 10% of the LEL before any spark producing activity is performed.

2.4 REQUIREMENTS: -

a. Where combustible gas levels ≥10% of the LEL are detected (by a portable combustible gas analyzer or similar detector), the Site Safety Officer shall increase the monitoring frequency of the borehole in accordance with applicable work procedures.

b. No spark producing activity (grinding, welding, or cutting) will be allowed when combustible gas levels ≥10% of the LEL are detected in the borehole. If it is necessary to grind, weld, or cut when combustible gas levels ≥10% of the LEL are detected, actions required by the work procedures shall be implemented (e.g., installation of bladder seal, purging of borehole, etc) to reduce the combustible gas levels below 10% of the LEL before work is performed.

2.5 SURVEILLANCE: The Site Safety Officer is responsible for monitoring of the borehole to assure that combustible gas levels are <10% of the LEL prior to any spark producing activity. Compliance with the requirements of this OSL shall be documented in an auditable log or Field Activity Report.

2.6 RECOVERY: In the event that combustible gas levels are found to be ≥10% of the LEL, approved engineering controls (e.g., purging, bladder seal, etc.) shall be implemented according to the work procedures to reduce the levels prior to any spark producing activity.

2.7 BASIS: This OSL is conservatively based on the potential for combustible gases to be ignited from sparks generated from cutting, welding, and/or grinding at the borehole.

5.2 PRUDENT ACTIONS

Prudent actions are commitments to ALARA goals and are generally good engineering work practices. Credit is given to the EIIs in WHC-CM-7-7, the HWOPs, and RWPs for providing safe work practices for performing the groundwater well drilling and support activities. Two specific prudent actions are identified below.

Function 1 - Minimize exposures to hazardous volatile gases (e.g., CCl_4).

Prudent Action 1 - If drilling in areas where air concentrations could approach or exceed occupational limits for hazardous vapors, appropriate protection measures should be taken to minimize personnel exposures.

Function 2 - Minimize potential for skin contaminations.

Prudent Action 2 - Don personnel protective clothing appropriate for handling potentially contaminated groundwater (rubber gloves, gauntlets, etc.).

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WHC-CM-7-7, *Environmental Investigations and Site Characterization Manual*, Westinghouse Hanford Company, Richland, Washington.

- EII 4.2, "Interim Control of Unknown, Suspected Hazardous and Mixed, and Radioactive Waste."
- EII 4.3, "Control of CERCLA and Other Past Practice Investigation Derived Waste."
- EII 4.4, "Control and Storage of Radioactive Materials and Equipment."
- EII 5.2, "Soil and Sediment Sampling."
- EII 5.4, "Field Decontamination of Drilling, Well Development and Sampling Equipment."
- EII 5.8, "Groundwater Sampling."
- EII 5.11, "Sample Packaging and Shipping."
- EII 6.4, "Resource Protection Well Services."
- EII 6.6, "Resource Protection Well Characterization and Evaluation."
- EII 6.7, "Resource Protection Well and Test Borehole Drilling."
- EII 6.8, "Well Completion."
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EII 8.3, "Remediation of Groundwater Wells."
EII 10.1, "Aquifer Testing."
EII 10.3, "Purgewater Management."
EII 10.4, "Well Development Activities."

APPENDIX A

SAFETY CONDUCT ON JET SHOT SERVICE JOBS

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SAFETY CONDUCT ON JET SHOT SERVICE JOBS

I. The Power Plant is to be turned off on all perforating jobs until the gun is lowered a safe depth into the well bore.

A. If log prints are being made, complete the printing and turn off power plant before installing gun on line and lower gun to a safe depth into the well or discontinue printing long enough to install gun and lower to a safe depth before starting power plant.

B. If it is doubtful that a gun did not detonate properly, the power plant is to be turned off before retrieving the gun from the well bore and the line jack placed in safe position.

C. Blasting caps are not to be installed on any type gun in the truck operating compartment or the truck cab.

D. Blasting caps are not to be installed on any type gun until gun is ready to be lowered into the well bore. Armed guns are not to be transported on any vehicle.

E. Guns that do not detonate properly shall have the cap removed immediately upon recovery from the well bore. The cap leads are to be shorted and the cap returned to the approved carrying case.

F. No open face electric heaters are to be used in the operators compartment. Only factory installed heaters are to be used.

G. Only the minimum required number of personnel shall be in the work area when the gun is capped. Keep all customer personnel clear of the area.

CHAPTER IV - OPERATIONAL PRACTICES

A. LOADING VEHICLES FOR SERVICE JOBS

1. LIFTING: Follow lifting instructions - avoid strain.
2. HOISTS: Use a hoist whenever a tool, instrument or gun is too heavy or bulky for safe, easy lifting.
3. GOOD FOOTING: Keep back end of trucks and pickups free of oil and mud. Use a "floor dry" substance if necessary.
4. BALANCE YOUR LOAD: Load auxiliary trucks with weight evenly distributed to avoid unbalance.
5. TRUCK LOADS: Avoid overloading back end of auxiliary trucks to such a degree that headlight will blind oncoming drivers.
6. PLACEMENT OF LOAD: Carry regular equipment in its proper place, not thrown loosely on the truck floor. Avoid the possibility of articles falling out when the curtain is raised.
7. ARTICLES IN TRUCK CAB: Pieces of equipment normally carried in the truck cab should be secured to prevent movement in case of accident. Such articles as water cans, tool boxes, spare parts, etc., can become missiles unless a means of holding them in place is devised.
8. SECURING LOADS: Racks or tubes for tubular instruments and guns must be equipped with positive latches, clamps, boomers or air bags. All equipment carried in them must be securely fastened for hauling.
9. SECURING RADIOACTIVE SOURCES: IF THE VEHICLE BEING USED HAS A PORTABLE SOURCE SHIELD, BE SURE THAT ANY SOURCE BEING TRANSPORTED IS SECURELY LOCKED IN PLACE.
10. CARBON MONOXIDE: Never let motor run in enclosed areas while loading.
11. BACKING: Always have a signalman to direct backing of trucks.
12. AIR BRAKES: If truck is equipped with air brakes move truck only after air pressure has reached the established minimum limit.
13. CARRYING EXTERNAL LOADS - AUTOMOBILES: Cars with a carrying rack installed on the side for hauling instruments or other long tubular equipment must be loaded and driven with special precautions. Securely fasten the item being carried to prevent sliding or falling off, proper weight distribution and protruding fore and aft. A heavy instrument on the outer portion of a passenger car will cause serious imbalance of the vehicle and increase the probability of losing control.
14. LOADING PICKUP TRUCKS: Pickup trucks with carrying racks on both sides the bed and over the cab should be loaded to balance as nearly as possible. Never load two tools on one side, if this is the total load. Carry one on each side. Distribute all articles in the pickup bed to as nearly as possible equal weight from side to side and always as far forward as practical.
15. CARRYING RADIOACTIVE MATERIALS AND LOADED GUNS; TOOL CONTAINING RADIOACTIVE MATERIALS OR LOADED GUNS ARE NEVER TO BE CARRIED IN RACKS OUTSIDE A VEHICLE.

B. SAFETY TO AND FROM THE JOB

1. CHECK YOUR VEHICLE - PRE-TRIP INSPECTION: Before leaving for the job use your vehicle safety check lists, making sure truck is mechanically ready to go. Inspect tires for condition and inflation, headlights, clearance lights, turn signals, brake lights, brakes, air pressure for volume and leaks, windshield wipers and fire extinguishers.

2. DRIVE DEFENSIVELY AND SAFELY: Observe traffic rules and speed limits. Develop courteous driving habits. Drive defensively at all times. If roads are wet or covered with ice or snow - slow down. Any speed is too fast if you cannot control your vehicles. Prepare yourself against drowsiness. NEVER drive while sleepy.
3. PARKING: When necessary to park the truck while traveling to or from a job, you must take positive steps to prevent its moving while it is unattended.
   a. PARK WHERE SURFACE IS LEVEL when possible. If on a downgrade turn wheels into curb or parking stop, making sure the obstruction is sufficient to hold the weight of a heavy vehicle.
   b. LEAVE TRUCK IN GEAR; SET HAND BRAKE.
   c. If PARKING PARALLEL to a curb where ROAD IS SLOPING, cut front wheel INTO the curb in the direction of slope.
   d. ALWAYS USE CHOCK BLOCKS when parking truck where terrain slops enough for truck to roll either forward or backward unrestricted, and gears and/or hand brake are the only other restraining forces.
   e. PARK WHERE IT WILL NOT BE NECESSARY FOR THE VEHICLE TO BE MOVED until you are READY TO LEAVE.
   f. LOCK TRUCK DOORS. ALLOW NO UNAUTHORIZED PERSON TO OPERATE OR DRIVE COMPANY TRUCKS.
   g. NEVER RELY ON HAND BRAKE ALONE TO HOLD PARKED TRUCK. If brake is air or hydraulically operated, pressure will bleed off and brake will be useless on some units.
4. RADIOACTIVE MATERIALS AND EXPLOSIVE: In the event of an ACCIDENT involving one of our vehicles carrying either EXPLOSIVES OR RADIOACTIVE MATERIAL, the following CRITICAL STEPS should be taken to prevent human exposure to the obvious dangers created by the accident.
   a. EXPLOSIVES, such as loaded jet guns or bullet guns, blasting or auxiliary caps or any type of explosive components used in loading a charge-actuated device, must be given first consideration. If the vehicle is involved in a collision or upset, fire is always a possibility. The immediate objective then is to quickly remove the explosive from the fire zone, if possible to do so safely. The explosive items should be watched by an employee or other responsible person to prevent molesting or unauthorized removal. The vigil should continue until the explosive are reloaded onto a company truck or other approved carrier for transportation to base or job. If explosives cannot be safely removed, everyone should be warned of the danger. A barricade should be set up to prevent anyone driving or walking by the vehicle until danger is past. In all cases, immediately inform highway officers and other gathering at the scene that explosives are aboard the vehicle.
   b. RADIOACTIVE MATERIALS: Should a vehicle carrying radioactive materials be involved in an accident, the source, in its shield, will be removed from the vehicle, if at all possible, and protected under close supervision at a safe distance until it can be transported by another company vehicle to its destination. In the event a source or sources cannot be removed from the vehicles, police and fireman are to be notified immediately and the truck isolated to avoid possible radiation exposure to officials and bystanders. IMMEDIATELY NOTIFY YOUR DISTRICT

OFFICE OF SUCH AN OCCURRENCE SO THAT THEY MAY SATISFY STATE AND A.E.C. REPORTING REQUIREMENTS.

C. SAFETY CONDUCT ON SERVICE JOBS

1. SAFETY PERFORMANCE - IMPORTANCE: We must develop and practice workable accident prevention procedures while on customer premises. To be leaders in our business, we must also be leaders in safety. Customers will usually favor a company which demonstrates a sincere desire to do a job safely without delays due to accidents and without exposing their people or equipment to unnecessary risk.
   a. KNOW HOW TO DO THE JOB SAFELY. It is MANDATORY that all employees have full knowledge of Jetco procedures before being allowed to perform the respective jobs. It is the District Manager's responsibility to fulfill this requirement.
   b. CLOTHING AND PROTECTIVE EQUIPMENT - WHILE ON JOB: All personnel must wear approved safety hats while on customer premises. Safety-toed shoes are to be worn by service personnel.
   c. LOCATING EQUIPMENT AT WELL-SITE: When arriving at the well-site, park where our men and equipment will be least likely to interfere with customer's normal work traffic. Stay clear of areas where there is a danger of falling objects, falling pipe, etc. until ready to unload.
   d. SMOKING: Never smoke on customer's property until you are sure you are in an area approved by the customer for smoking. If it is a perforating job on a well under pressure, or if there is gas escaping from the well, there is probably no area approved for smoking.
   e. GROUNDING: On all wireline fobs the approved ground wire must be connected between truck, rig and wellhead. Continuity of grounding circuit must be assured at all times.
   f. COMMUNICATIONS EQUIPMENT: Oral communications equipment must be assured at all times.
   g. LUBRICATORS AND OIL SAVERS must be kept in good workable condition, ready for use at all times. When preparing to perforate where pressures are a possibility, a lubricator must be installed. It is considered basic that an approved type bleeder out-let be built into all lubricators for bleeding pressure and providing a pumping intake connection. A 2" heavy-duty collar with 8-round thread is standard. A heavy-duty valve must be installed before perforating.
      1. PROTECT YOUR HANDS: When rigging up lubricator equipment, special measures must be taken to prevent injury to hands and fingers caused by the packing gland assembly sliding down the line to the cablehead. Any time the packing gland assembly is installed on the cable prior to hoisting the tool into position for running in the well, the unit must be secured to the cable.
   h. CONTINUITY CHECK OF BLASTING CAP CIRCUITS: A Simpson (or equivalent) meter must NEVER be used when checking continuity of a circuit where a blasting cap or auxiliary cap is installed. An ohmmeter galvanometer only is approved for this continuity check.
   i. NO SHORTCUTS ALLOWED: Shortcuts such as circuit "jumpers" or wired switches must never be used on perforating equipment. No electrical repair work or circuit alterations may be made while gun is attached to cablehead.

j. CHECKING CABLE RESISTANCE: "When checking cable resistance with truck power, the cable head shall be brought to the hoist."

k. GROUNDING AND CHECKING FOR STRAY CURRENTS: Before attaching the cablehead to any type perforating gun, carefully ground the cable head contact block to cable shroud or head to eliminate possibility of stray current remaining in the line. Recheck with ohmmeter galvanometer. Double check by shorting galvanometer leads and observe reading. If galvanometer has been damaged by stray current, do not attach cablehead to gun until source has been located and eliminated.

l. ELECTRICAL, THUNDERSTORMS, DUST STORMS: Perforating operations must be suspended and loaded guns safety isolated if electrical storms, thunderstorms or dust storms should appear imminent in the area on the job. The exact time to shut down must be agreed upon with the customer.

m. MOBILE TRANSMITTERS must not be operated within 350 feet of any perforating operation using blasting caps in the firing process. When this distance is impossible to achieve, as it would be on offshore jobs, transmitter switches must be in "OFF" position until sufficient preparation has been made to eliminate danger.

n. PRIMACORD, CAPS AND BOOSTERS: If primacord is transported to a job place in separate box away from caps or boosters. Never cut primacord with diagonal cutters, use only primacord cutters or sharp knife. Crimp caps and boosters only with approved crimpers. Isolate the loading point from other personnel. Allow no unauthorized assists.

o. HANDLING CAPS AND BOOSTERS: Blasting caps and boosters must be transported to the job in a cap carrying case (Class III magazine). The case is made of steel and lined with foam rubber. Caps are to be taken out only as used and the case kept closed at all other times. The foil shunt which holds the bare ends of cap leg wires together must remain in place until caps are ready for use. Place cap in heavy steel container, such as bull plug, while connecting leg wire into gun firing circuit and prior to making the cap-primacord connection.

p. ONLY THE EMPLOYEE making lead wire connections shall be allowed to fire the gun. Lead wires shall remain shorted and not connected to power source until gun is ready to go into well.

q. AFTER PERFORATION: When equipment, such as fired guns, has served purpose for the job being performed, remove it from the work area. Keep the rig floor as clean as possible. When the job is finished ensure no scraps of primacord of blasting caps are left lying on rig floor. As caps and primacord are used, scraps, faulty caps or unfired charges should be immediately placed in an approved carrying container for transporting back to the base.

r. HANDLING HEAVY EQUIPMENT: The most common cause of injury to our field employees while on service jobs is muscle strain caused by improperly lifting and handling heavy equipment. Some of our equipment is too heavy for two men to handle. It is then necessary to solicit extra help at the rig or use power assistance such as a catline. When rig power is used, the equipment must never be operated by Jetco employees - only customer personnel, preferable the driller.

2. HIGH-PRESSURE WELL SAFETY:
   a. TRAINING AND SAFE PERFORMANCE - IMPORTANT: Performing work on wells under pressure can be extremely dangerous if personnel are not properly trained and do not follow safety procedures. Lubricator equipment is now in service that has a working pressure of 10,000 psi and a test pressure of 15,000 psi. It is possible to go into wells and perform completion services with wellhead pressures up to 7,000 psi. These safety instructions were compiled from years of experience in working on high-pressure wells.
      1. USE PROPER CONNECTION FOR THE PRESSURE: Threaded joints are not considered safe for working with pressures above 5,000 psi. Flanged wellhead connections and specially fabricated lubricator sections should be used on wells where the pressure is expected to exceed 5,000 psi.
      2. PRESSURIZED LUBRICATORS - DANGER: Never climb a lubricator when there is pressure confined. Any horizontal movement will place additional stress on the lubricator threads and may cause it to be blown off.
      3. HYDRAULICALLY OPERATED CONTROL HEADS AND BLOW-OUT PREVENTERS are required safety equipment on high-pressure completion units.
      4. CHECK FOR PRESSURE: Always check to be sure there is no pressure on a wellhead or lubricator before attempting to work on it. A wellhead, lubricator, flow line or any closed system may contain high internal pressure and must be checked by opening a bleed-off valve. Always make it a practice to check the wellhead for pressure before figging up. After the tools are pulled into the lubricator close the master valve and bleed the lubricator before releasing packing gland.
      5. BE ALERT FOR SIGNS OF TRAPPED PRESSURE WHEN BACKING OFF A CONNECTION OR UNION: Threaded connections and threaded unions (Bowen) are difficult to back off when they are under pressure, and provide a warning of pressure in the system. Uni-bolt unions can usually be broken by one blow with a hammer, regardless of the amount of pressure on them. The bolt on the uni-bolt union should be loosened but never taken out or nut completely removed until the union is broken. If there is pressure the blase will be deflected downward and the lubricator held in position.
      6. MULTIPLE COMPLETION WELLHEADS: Employ extreme caution when working on a multiple completion wellhead. The multiple completion wellhead is two, three or four wellheads built into one assembly. This increases the chances of error in opening or closing the wrong valve. Always stop and study the wellhead before closing a valve or breaking a connection.
      7. SWAGES AND UNIONS: Inspect the inside surface of swages and unions for wear by the perforating cable.
      8. WING VALVES: Never open a wing valve while the tools are in the tubing if the well has pressure on it. This would usually result in the tools being blown up the tubing past

the cable. The wing valve should be kept closed at all times, even if the well has no pressure on it.

9. FLOW HOSE: The flow hose must be tied down securely. A high volume of low through the flow hose can cause it to swing back and forth around the wellhead creating a serious hazard.
10. SAFE WORKING POSITION: Never place any part of the body in the path of high velocity fluids or gases. This will cause serious damage to the skin.
11. DO NOT TOUCH FROZEN PARTS: Do not touch any part of the control head or flow hose that is frozen due to the rapid expansion of gases. Frostbite may result even if the hands are exposed only for a short period of time.
12. USE HIGH PRESSURE LINES: Always use high-pressure chick-san steel pipe instead of rubber flow hose on wells with extremely high pressure.
13. FROZEN FLOW HOSE: Never flex or knock ice from a frozen flow hose. This may cause the rubber in the flow hose to break.
14. LENGTH OF FLOW LINE: Sufficient flow hose or pipe should be used to discharge oil or gas in a safe area on the down-wind side of the rig.
15. SMOKING: Never smoke near a wellhead or discharge line.
16. SPOT TRUCK UPWIND: Always spot the perforating truck on the up-wind side of the location.
17. STARTING MOTORS: Never start a motor near the wellhead if gas is present.
18. EQUIPMENT UNDER PRESSURE MUST BE ATTENDED: The wellhead and pressure control equipment should never be left unattended while operating under pressure.
19. STABBING BOARDS: When using a stabbing board with the lubricator, make certain the board is securely fastened at both ends. A SAFETY BELT should always be worn by employees working on the board. The board should be kept clean and dry.
20. HANDLING GUNS: Avoid taking hold of gun when lowering it into the lubricator head. Guide with the palms and save the fingers. Keep wrench burrs and steel slivers filed off the guns.
21. WORKING NEAR PRESSURIZED EQUIPMENT: Stay clear of pressurized lubricator, flow lines and the wellhead except when required to work on the rig floor. Take rig speaker a safe distance from danger zones when perforating under pressure or when run is being made to assure quick two-way communications in case of emergency. Return to regular position when gun is back in lubricator and master gate is closed.
22. BLEEDING OFF PRESSURE: Bleed pressure from lubricator before loosening pressure packing gland.

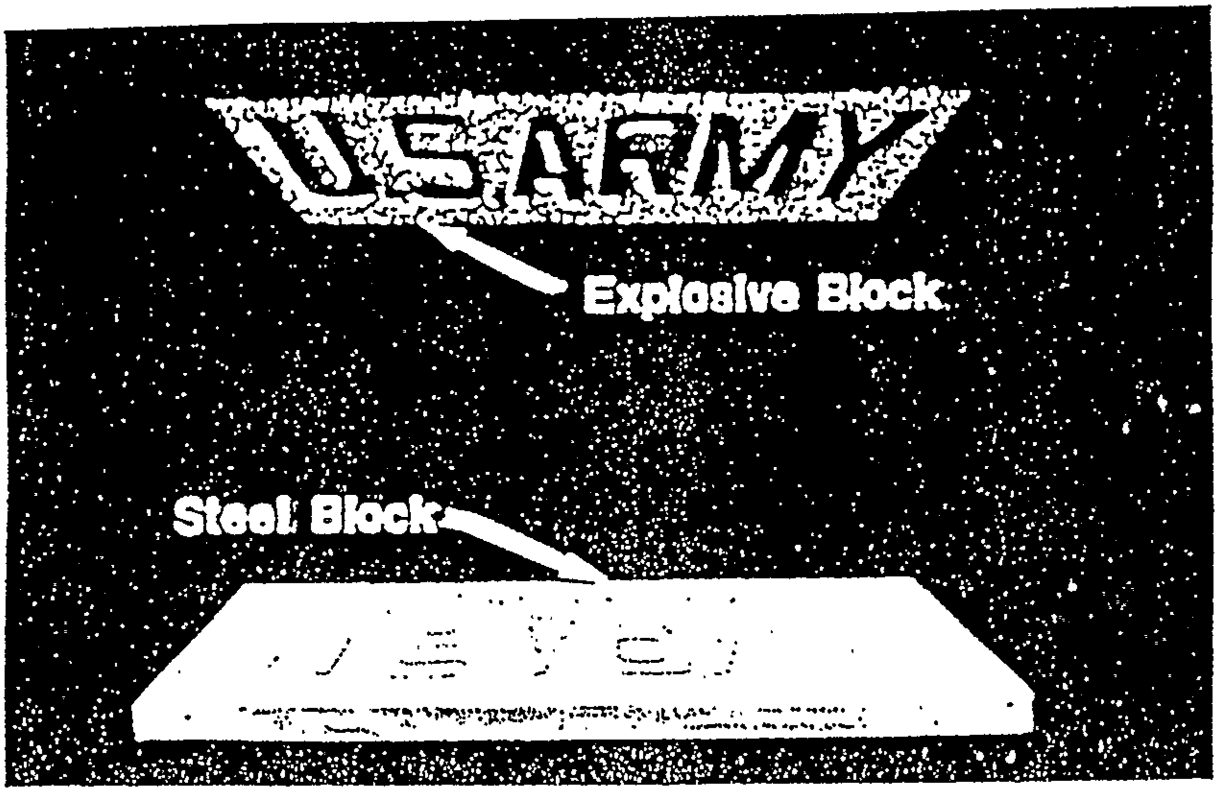
NOTE: WELL-SITE MEETINGS: Under certain conditions a safety meeting should be held on location prior to the job. Locations where safety hazards exist; high pressure wells; radioactive tracer jobs, etc. are examples. These safety meetings may include only Jetco personnel or company representatives may be invited.

D. SAFETY AT THE LOCATION AFTER THE JOB

1. PREPARING TO LEAVE WELL-SITE: Back truck or pickup to the most convenient place for loading near rig floor or catwalk. Avoid lifting heavy equipment unnecessarily. Use caution. If gas is being emitted into atmosphere near the wellhead do not take truck near it for fire precaution reasons.
2. PRESENCE OF GAS: The Onan and truck motors should both be shut down if gas pressure has been created and is leaking through the lubricator oil saver or blowing from the wellhead until such time as our operator and the customer can agree that it is safe to resume operations.
3. EXPLOSIVES: If job was perforating, be sure all types of explosive components are removed from rig area and properly returned to carrying containers. Before loading on truck, disarm any gun or tool actrated by explosive charge.
4. PRESSURIZED CASING JET GUNS: Casing guns fired under pressure, with heavy mud, will occasionally return to the surface with pressure confined. When a casing gun reaches the surface it should be determined immediately if there is a likelihood that pressure is confined by heavy mud. The pressurized gun should be handled very carefully from the time it is pulled from the wellhead or lubricator, during the laying down procedure and while removing the cablehead. The greatest danger is to the eyes and skin because of the possibility of pressure being released through a port with considerable force. Logical protection here would be to wear safety goggles and shield the skin by standing out of the path of the charge ports. The gun must be isolated until it can be safely loaded on the truck and returned to the base where planned procedures can safely expel any remaining pressure.

E. SAFETY ON ARRIVING AT SHOP AFTER JOB

1. FATIGUE: Upon returning to the shop extra effort is required to off-set fatigue which may cause laxity of observance of careful working standards.
2. EXPLOSIVES: All explosive components such as blasting caps must be stored in ship Class II magazine and are not to remain on truck.
3. DOUBLE CHECK TO SEE THAT GUNS ARE DISARMED: Guns or other tools actuated by explosive charges must always be disarmed before storage. This is a double-check to follow up instructions to disarm all guns, etc. before loading on truck at finished job.
4. REPORT UNSAFE EQUIPMENT: Report any truck or equipment in unsafe condition to your manager.
5. REPORT ALL INJURIES: Report to your manager any injury or accident of any type that may have occurred during the period you were away from the shop.

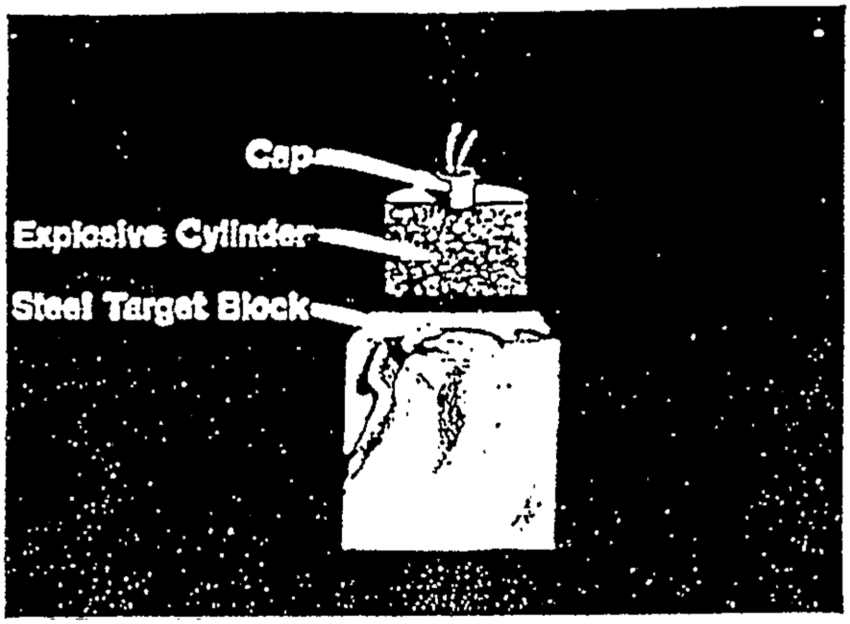


Jet perforating involves providing communication between the producing formation and the casing. This is accomplished by shooting holes through the casing, cement, and into the formation.

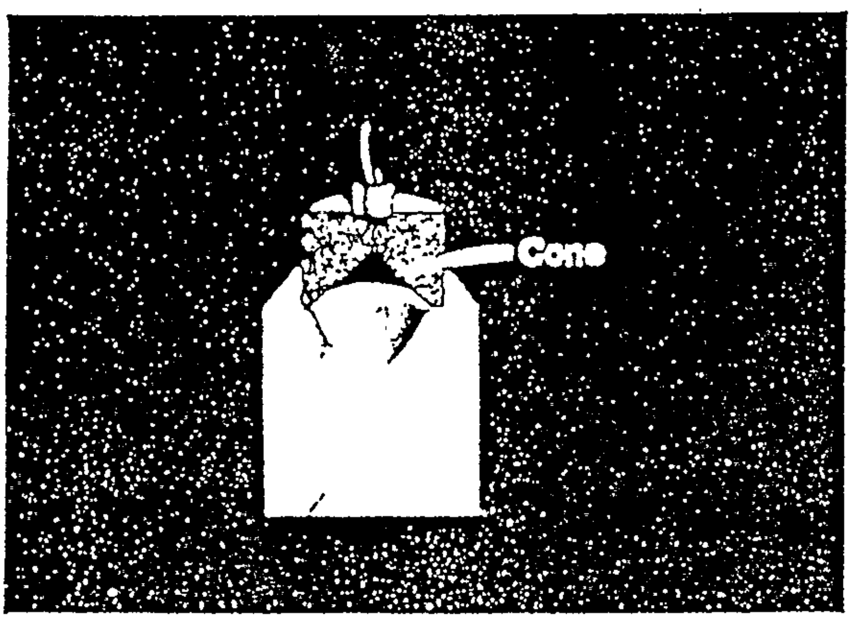
Jet perforating was introduced to the oil field shortly after World War II as an improvement over bullet perforating. It was adapted from the military "bazooka" charge used for shooting holes in tank armor. Today, over 90% of the world's perforating is performed by jet charges, primarily because:

- Mechanical simplicity and reliability of the system.
- Availability of more power for available volume.
- Adaptability of its system to a broad range of completion requirements.
- Temperature stability of the explosive.

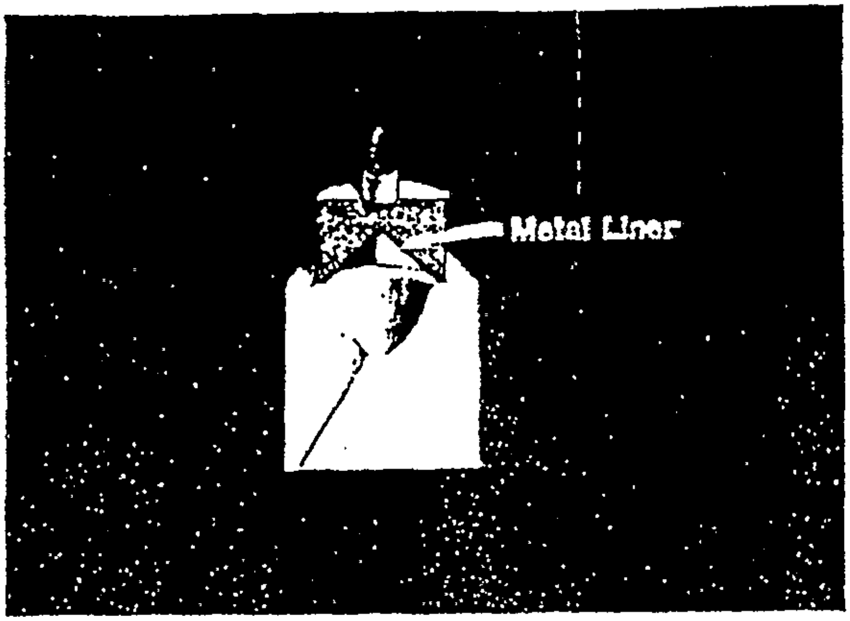
The jet principle, known originally as the "Munroe Effect," was first noted by an inspector of explosive tests during the Civil War. He noted the imprint of letters pressed in the explosive block in the steel block test after detonation.



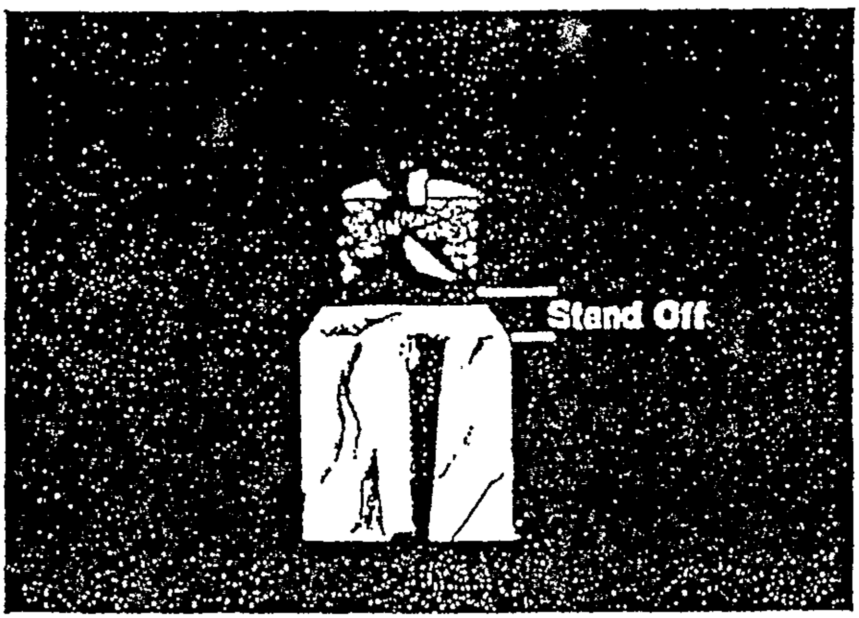
Subsequent tests of explosive masses detonated on steel test blocks indicated a "spalling" or flaking of the steel adjacent to the explosive. This was the result of the pressures created by the detonated explosive.



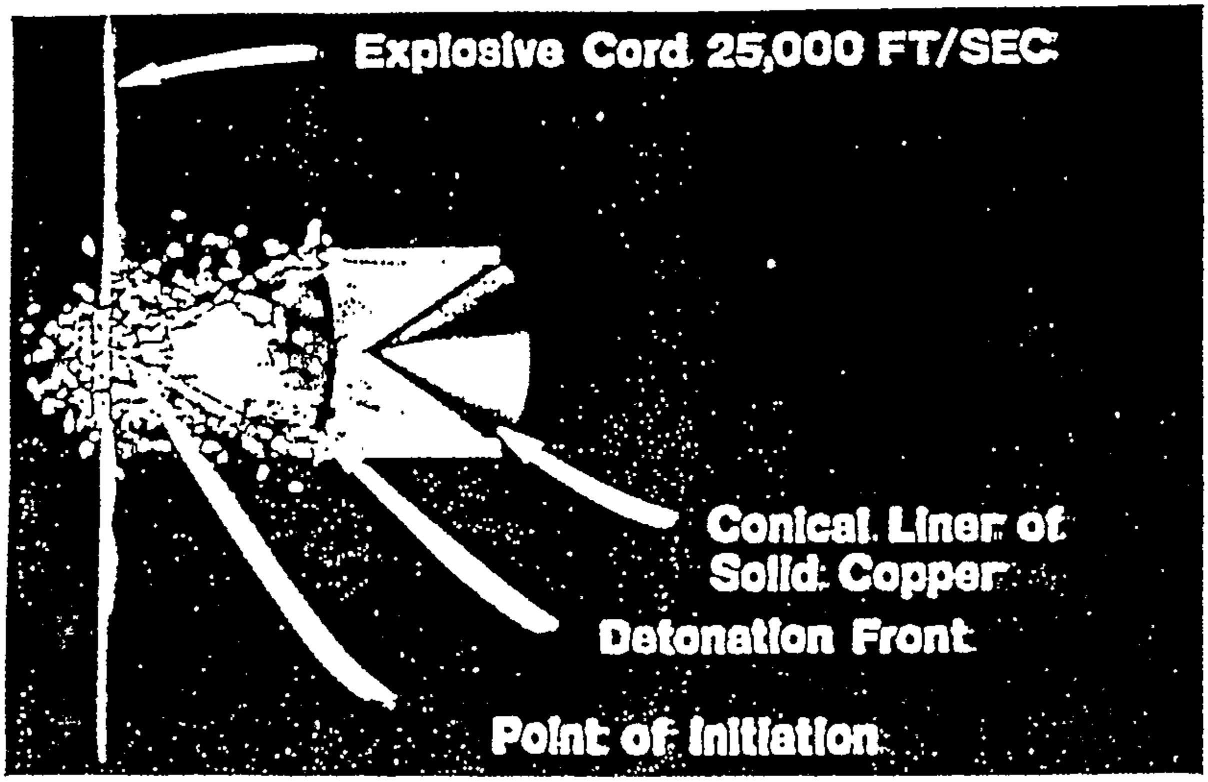
When a cone-shaped cavity simulating the letters in the original observation was pressed into the explosive mass, a depression was produced in the steel equal to about 1/2 the cone diameter.



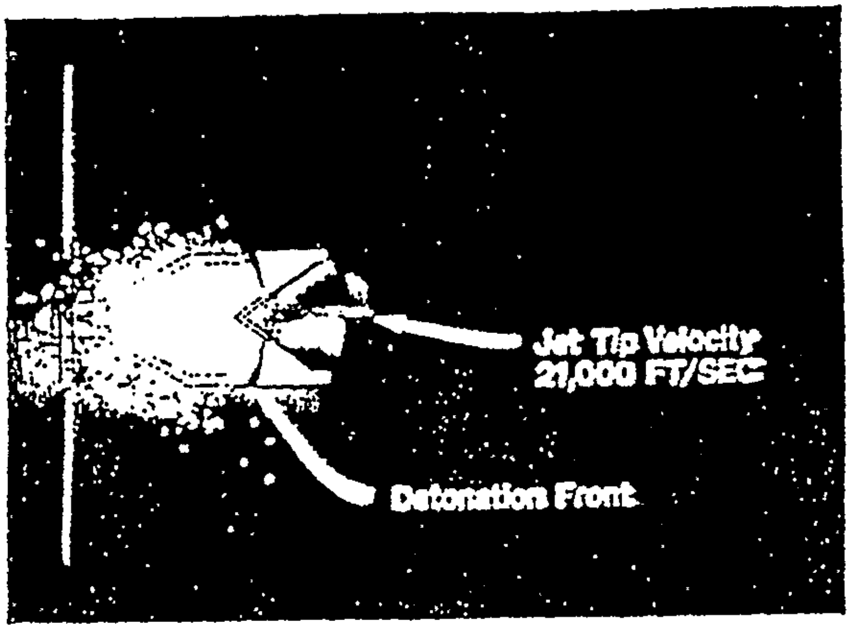
When the cavity in the explosive mass was fitted with a thin metal liner, the depth of the resulting cavity in the steel after detonation of the explosive mass was substantially greater than without the metal liner.



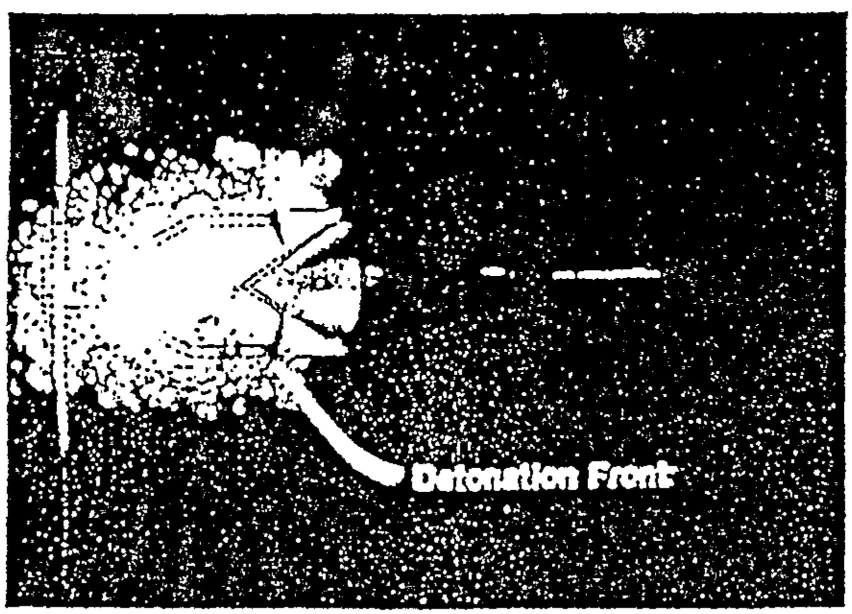
The modification which really made the difference was moving the "shaped" explosive mass away from the target, providing what is called "standoff". The standoff distance added dramatically to the effectiveness of the charge.



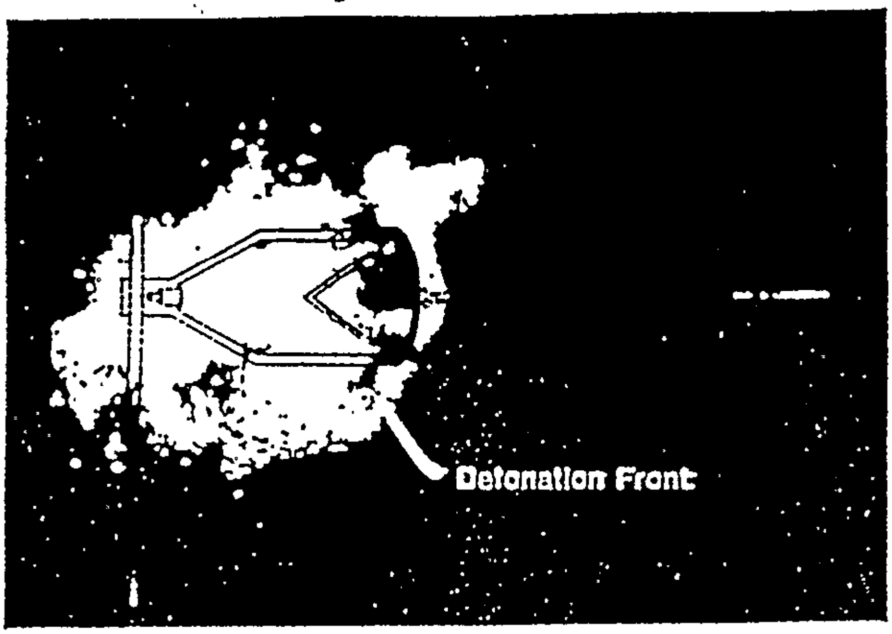
As the jet charge is detonated, shock waves are produced which move out from the explosive mass, perpendicular to its mass. Shock waves moving perpendicular to the cone-shaped cavity move the center of the cone and their resultant force drives them out the open end of the cone. While the charge is exploding like a hand grenade, approximately 10% of the force is concentrated in one directon. The shock of detonation is so great that it atomizes the metal liner. These metal particles are picked up by the concentrated force moving out the end of the cone. The result is a shock wave, travelling at 4 to 5 miles a second, weighted with metal particles. The inertial force of this system is sufficient to punch a hole through casing, cement, and into the formation.



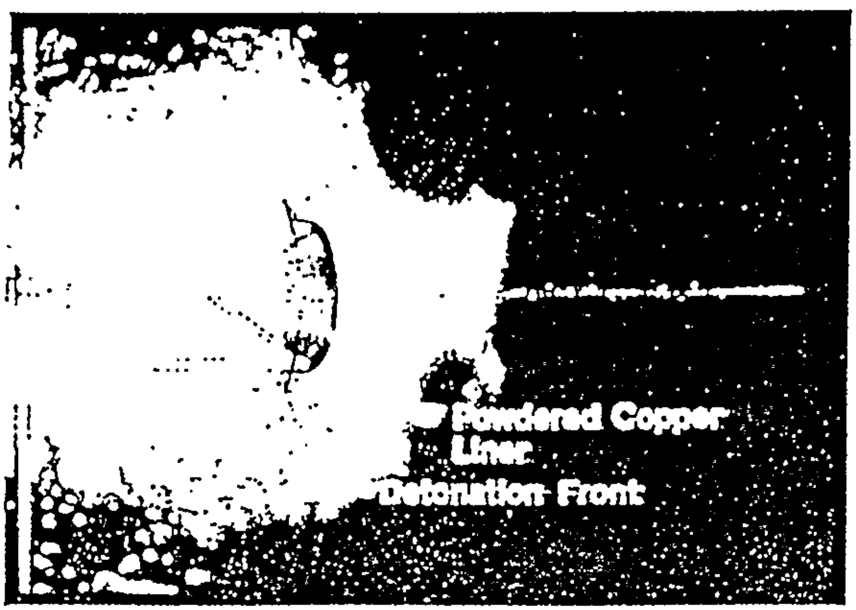
The detonation front vaporizes the cone and forces it along the cone axis toward the open end of the cone. That detonation travels about 30,000 feet per second through the charge and puts a pressure of 2-4 million pounds per square inch on the metal liner.



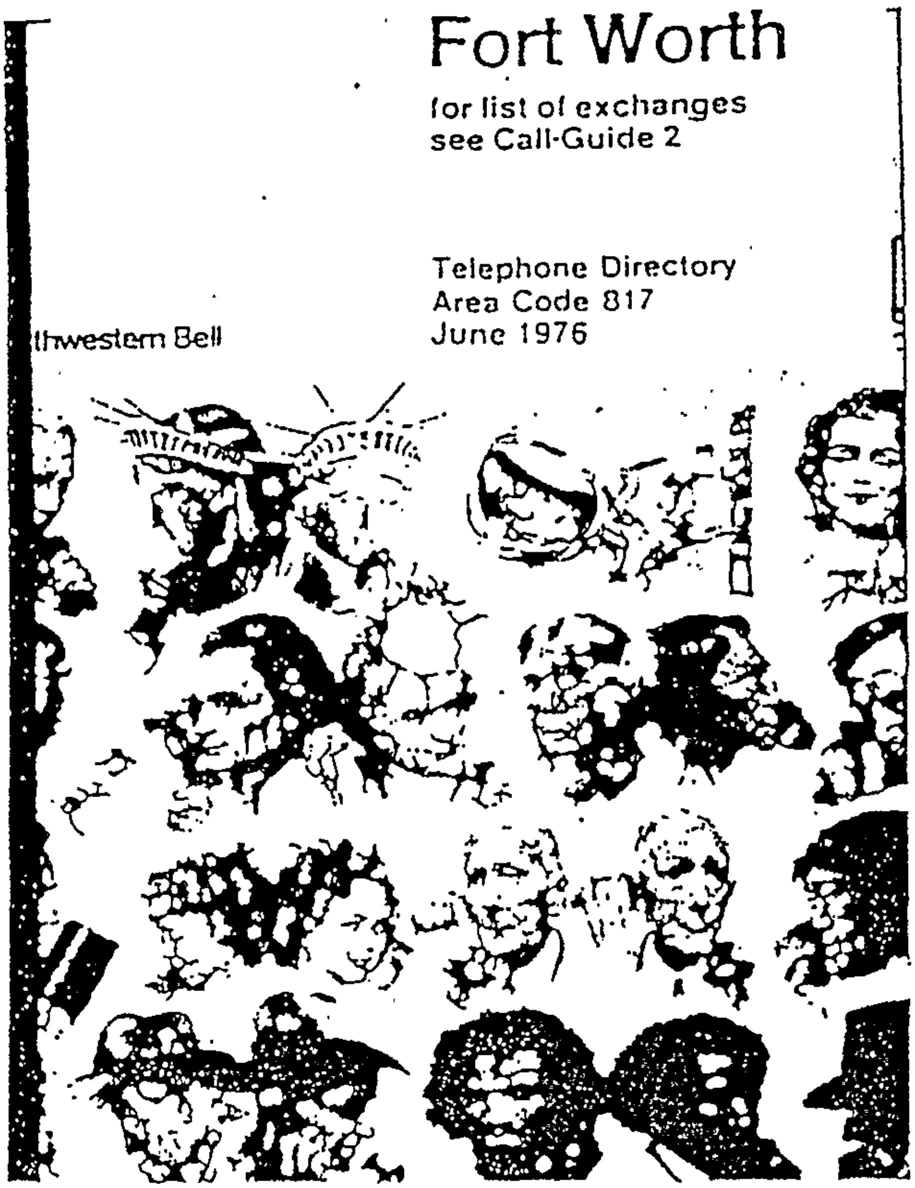
The jet stream lengthens as the metal is vaporized. This jet stream travels about 20-25,000 feet per second and exerts a force of up to 5 million pounds per square inch on its target. The longer the jet stream, the longer the force acts against the target and the deeper the penetration.



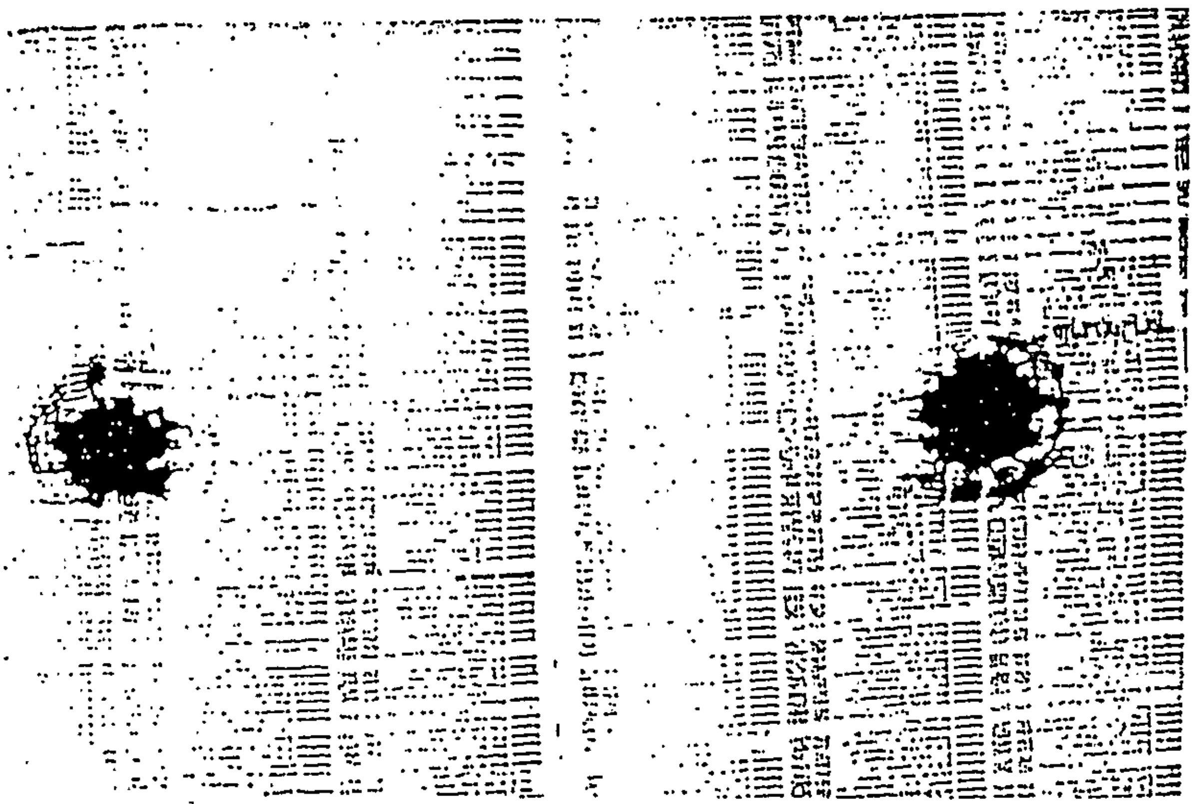
There is very little damage to cement or casing because of the speed with which the whole process takes place. It takes only 100-300 micro seconds (millionths of a second) from initiation to completion of penetration. Notice the mass of debris at the open end of the cone in the illustration. This is one of the problems a jet charge presents. When a solid metal liner (usually copper) is used, not all of the liner is atomized. What results is a metal slug or "carrot" being deposited in the perforation. This "carrot" acts as a plug, reducing the efficiency of the penetration.



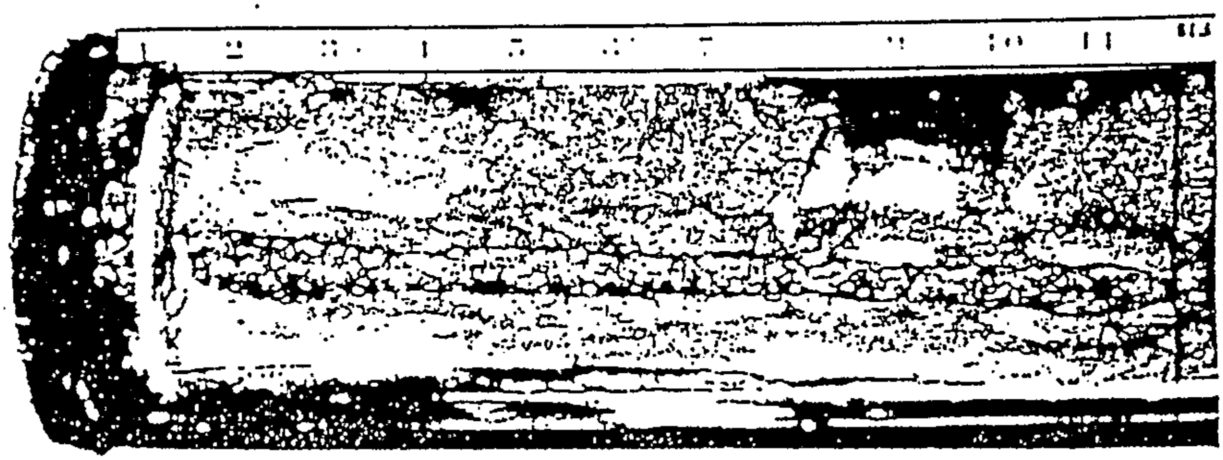
It has been found that a powdered metal liner atomize completely leaving no "carrot." The name of this type of liner is the DML (Disintegrating Metal Liner).



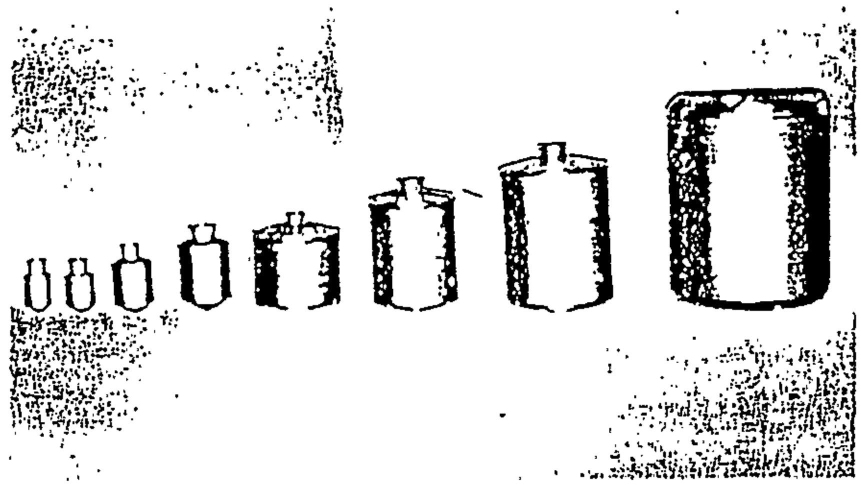
There is often a misconception about the heat generated during the detonation of the explosive mass. Some believe the jet "burns" its way through the material. Others fear that the high temperature will glaze the formation and render it impermeable. The speed of the entire reaction is so fast that there is no time for heat transfer. Heat, therefore, plays a negligible part in the jet process. A phone book through which a jet charge has been fired shows slight charring at the edge of the perforated hole, but no indication of burning.



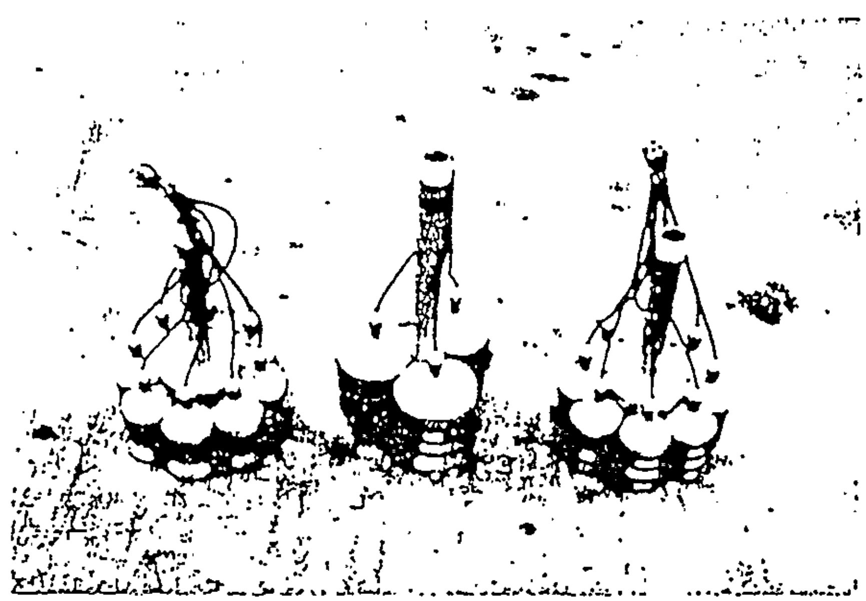
Even the thin pages inside the phone book show no appreciable heat transfer. Notice, however, that they do indicate a radial transfer of pressure resulting in a compaction of the material immediately adjacent to the hole. This is the principle of the shaped charge. As the weighted shock wave hits the target, it reverts to a radial force pushing everything to the side radially from the hole.



The formation also shows the effect of the radial compaction as caused by the pressure of the jet. Here is a closeup of a split Berea Sandstone target showing the perforation filled with wax. Notice the area of compaction in the Berea adjacent to the perforaton. This will tend to reduce the porosity and permeability of the formation immediately surrounding the perforation.



Another application for jet charges is called the Junk Shot. The jet is facing downward and is shot into junk dropped in the well (i.e. bit cones, bolts, etc.). The idea is not to perforate the debris, but rather to exert radial force against it and force it to the side.



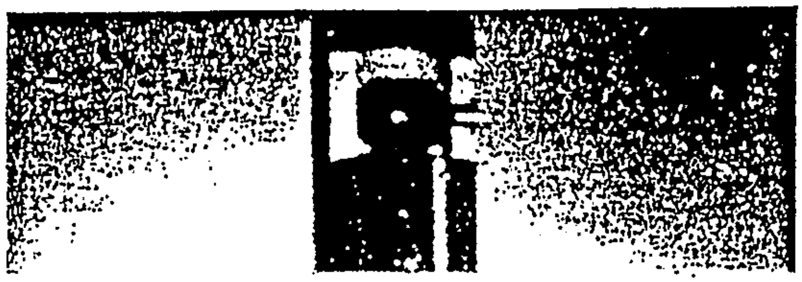
Junk shots can be designed in various configurations, including these combination charges for large diameter pipe.

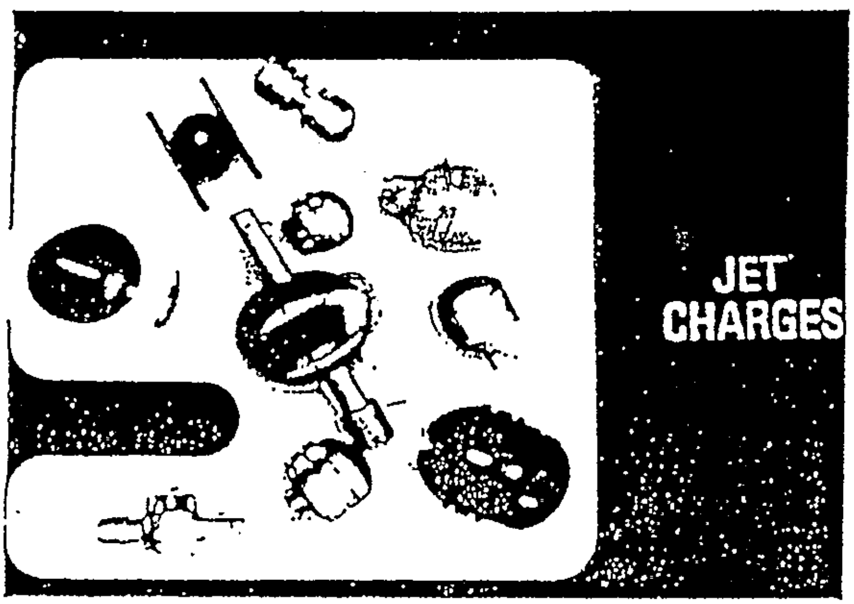
Another thing to be considered in jet perforating is shaped charge design and quality. The middle target was shot by a charge widely advertised for deep penetration. It did get penetration, but the hole diameter was so small that the bottom 2/3 of the perforation was packed with charge debris and was worthless for communication. The charge at the right does not provide a perforation of uniform diameter. This is important for maximum-effective penetration for a given amount of explosive charge. The charge on the left, has the best uniformity and penetration of the group.

When comparing charge performance, always use the proper API certified perforating performance data. Care should be taken to insure that all data be for either the API 43 Section I or Section II procedure for all charges. The two procedures are completely different, and a charge run under Section I conditions can not be compared to a charge run under Section II conditions.

It is recommended that only entry hole diameter data be taken from the API Section I Concrete Target Tests. Penetration figures should not be used for comparison because of the wide variation in compressive strengths of the concrete targets.

A reliable indication of charge penetration may be taken from the Section II, Berea Sandstone Target Tests because of reasonably uniform Berea targets.





One of the advantages of the jet principle is its flexibility. Jet charges come in many shapes and sizes along with a variety of materials which encapsulate the charge to protect it from well fluids.

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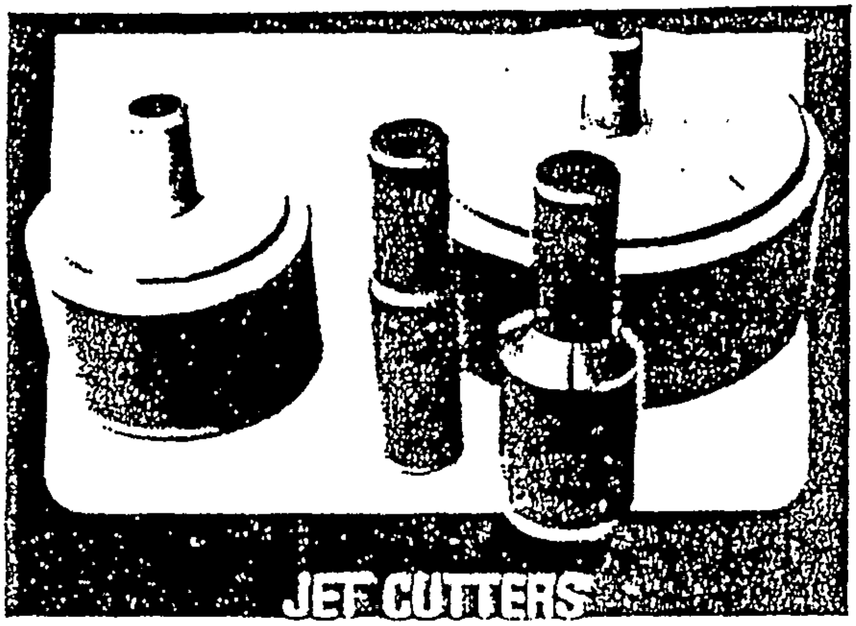
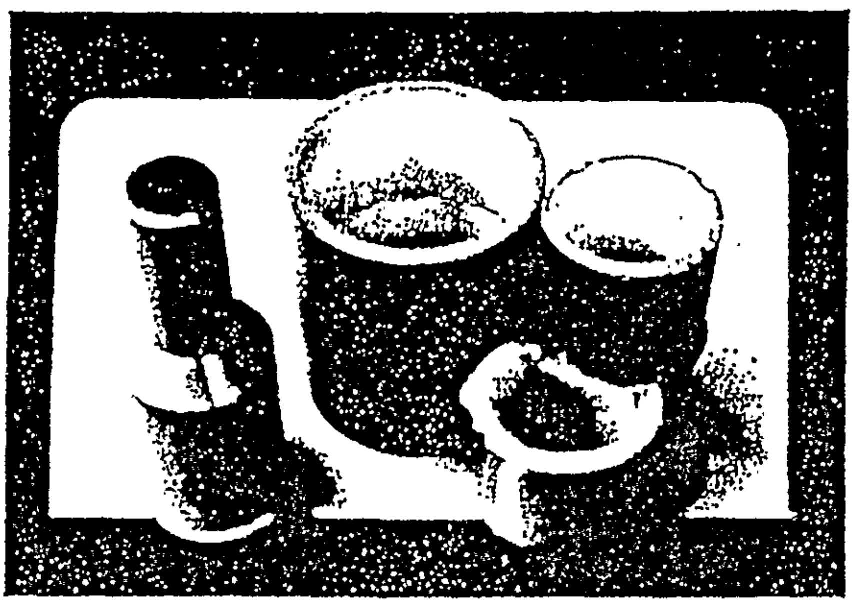
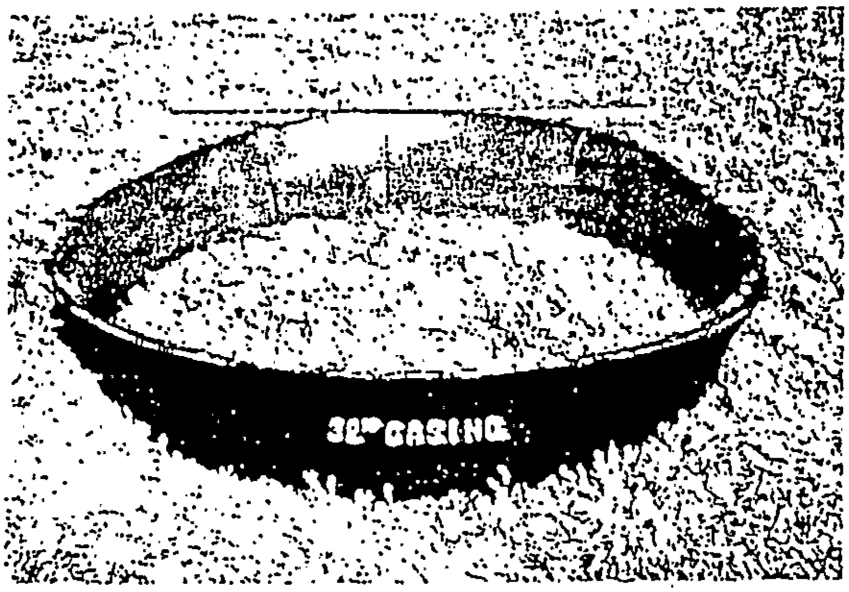


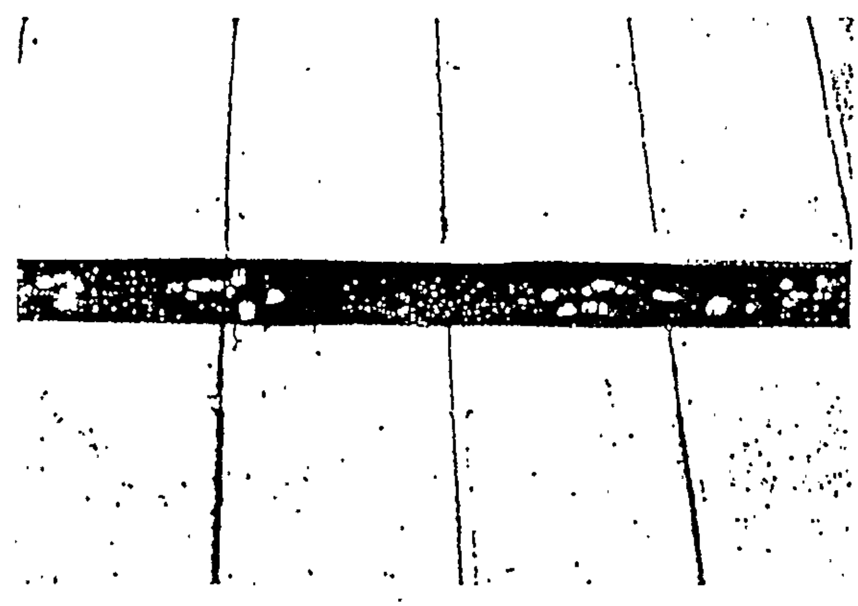
One of the more significant applications of the jet principle is the jet cutter. Instead of using a cone-shaped cavity, a 360° wedge is incorporated. This is similar to putting two pie plates together, bottom to bottom, filling both with explosives, and detonating them from a hole in the middle. Instead of creating a jet stream in only one direction, this combination gives a 360° jet which cuts the pipe.



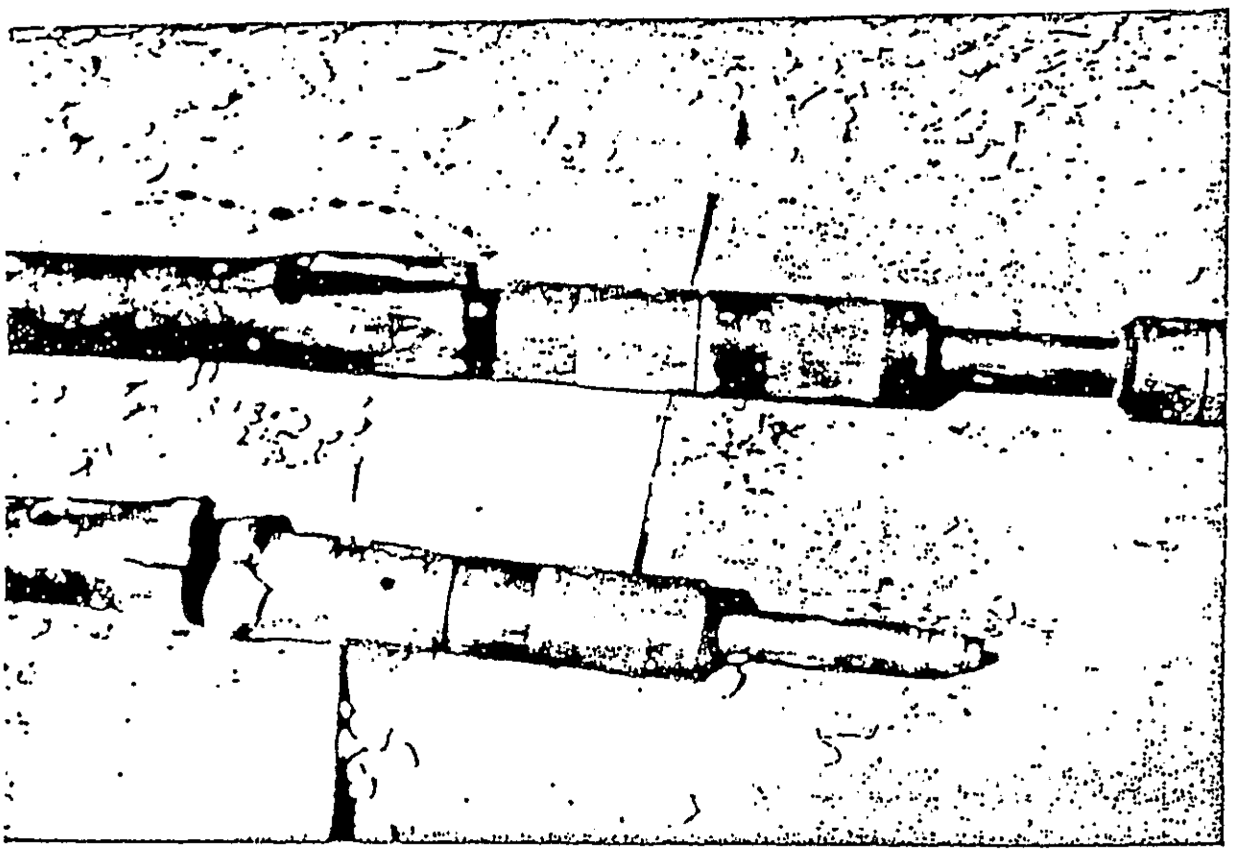
Jet cutters are designed to cut only the pipe into which they are placed. In the above example, tubing was placed tightly against the side of the casing and the cutter positioned tightly against the tubing. A small ridge was cut into the casing in the worst case, but there is not cutting through both strings of pipe. Jet cutters are inefficient, so it is imperative that the cutter be sized specifically for the type and size pipe to be severed. Too small a cutter might not sever the pipe because well fluids between the charge and the pipe dissipate much of the explosive energy.



This is a good example of the versatility and adaptability of jet charges. This 32" diameter casing was being used for piling on an offshore structure. It was cut with a jet cutter when the structure had to be removed and the location abandoned.

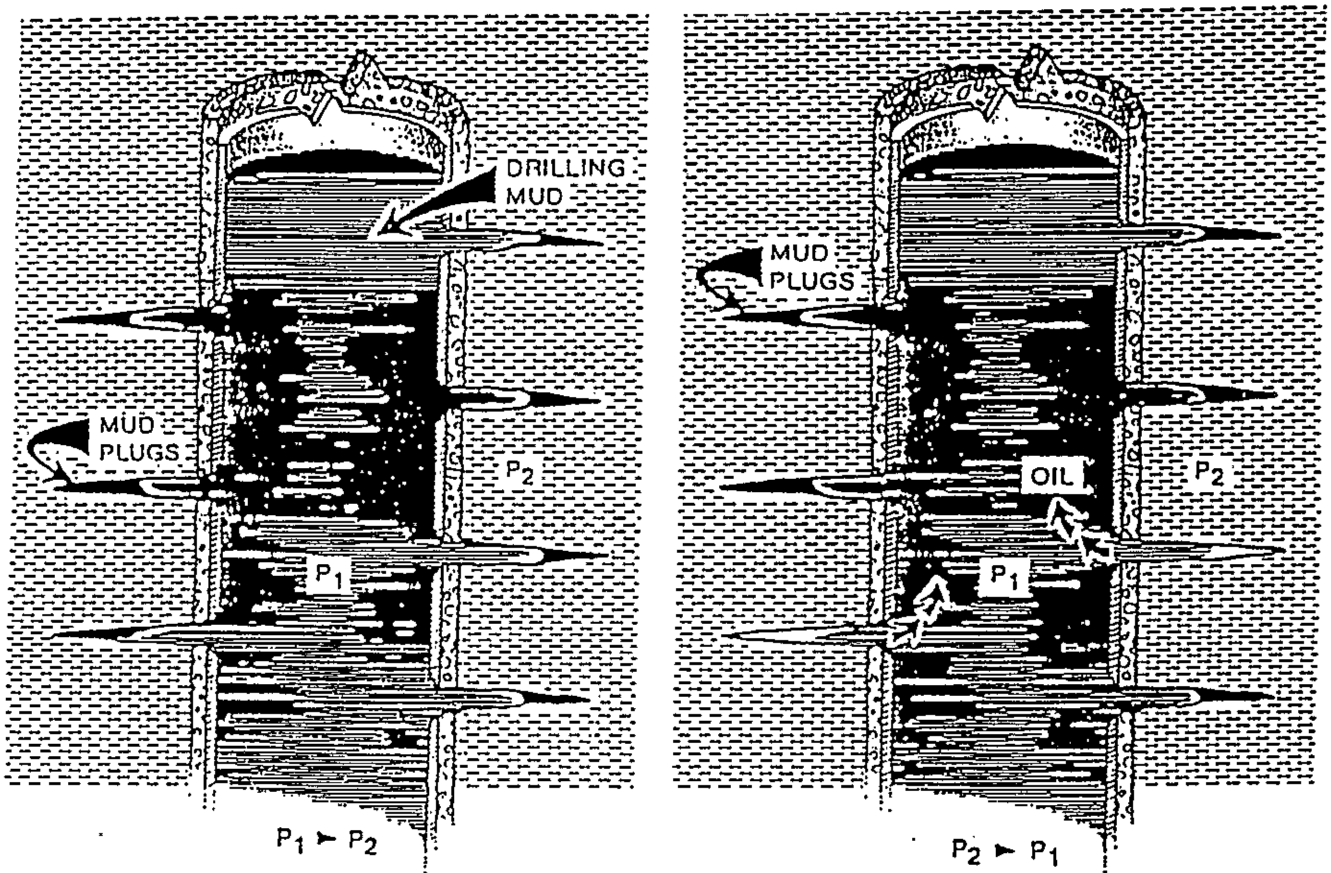


It is possible for a shaped charge to detonate but not to form a jet. This phenomenon is called low-order detonation. Low-order detonations will not produce perforations but do subject the surrounding area to substantial pressures. A charge may have a low-order detonation caused by either excessive temperature or pressure. When a capsule-type gun has a low-order detonation, the results can be dramatic as shown in the above illustration.



Not all the problems is jet perforating guns are restricted to thru-tubing capsule designs. These two, heavy-walled 4" hollow steel carriers split on consecutive runs in the same well. It has been theorized that an inexperienced gun loader left a kink in the prima cord which caused the primacord to be severed and improperly detonated. The resulting explosion could have forced all the charges and primacord to the top of the gun where there could have been a low-order detonation of the entire mass causing the gun to split.

ADVERSE EFFECTS OF PERFORATING IN DRILLNG MUD



DURING PERFORATING RESULTING IN MUD PLUGGED PERFORATIONS

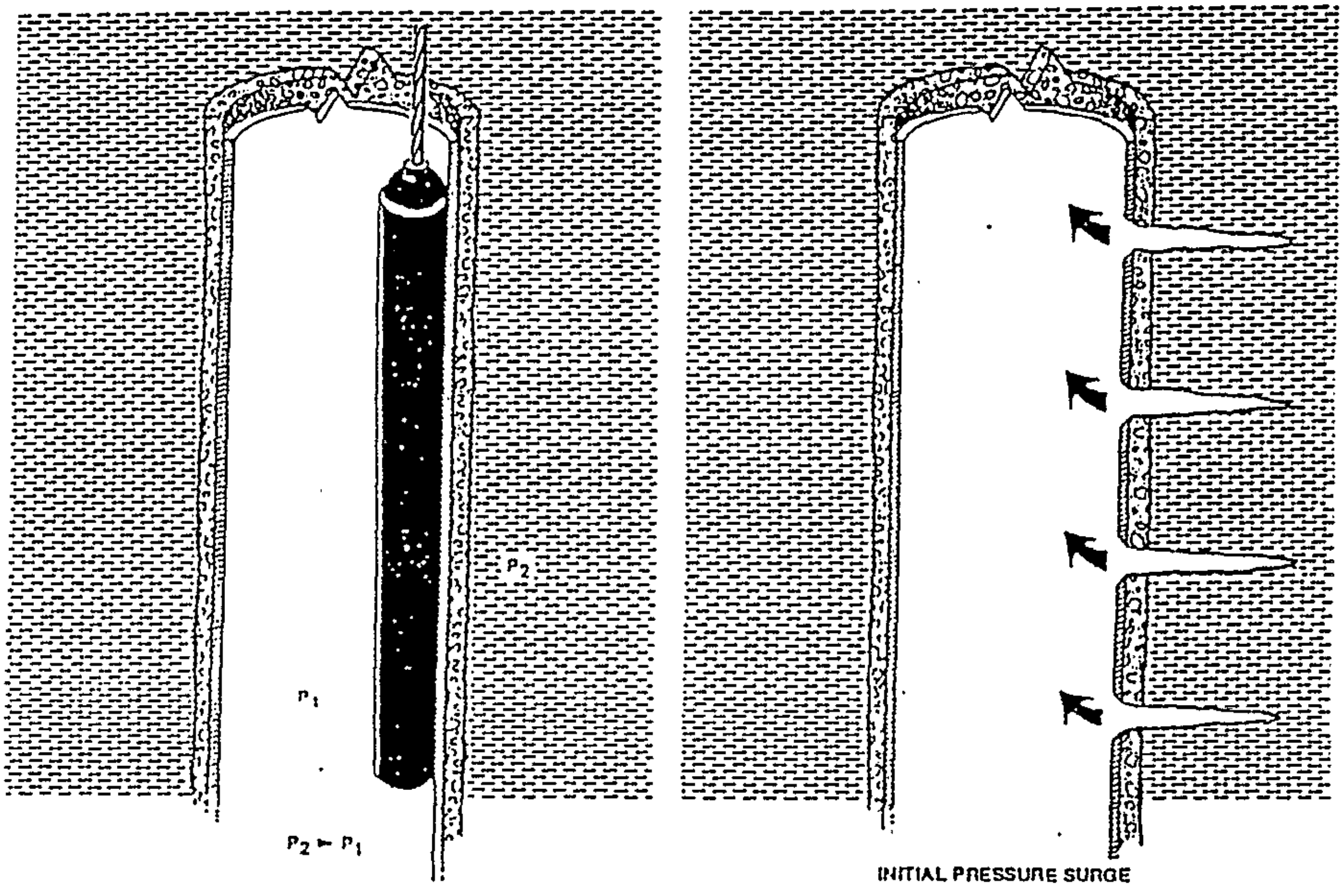
AFTER COMPLETION YET ONLY FEW PERFORATIONS PRODUCE

The efficiency of perforating in a well is not solely dependent on the design and performance of the shaped charge. Another factor is the condition of the well itself when the gun is detonated.

Figure #1 shows the result of perforating with mud in the hole when the hydrostatic pressure is greater than the formation pressure. Mud rushes into the new perforations forming solid plugs which block them.

Figure #2 shows the situation immediately after swabbing the well: Some perforations clean up because of the differential pressure created by the swabbing action. However, as soon as these perforations begin to flow, the differential pressure is reduced so that other perforations cannot be cleaned out.

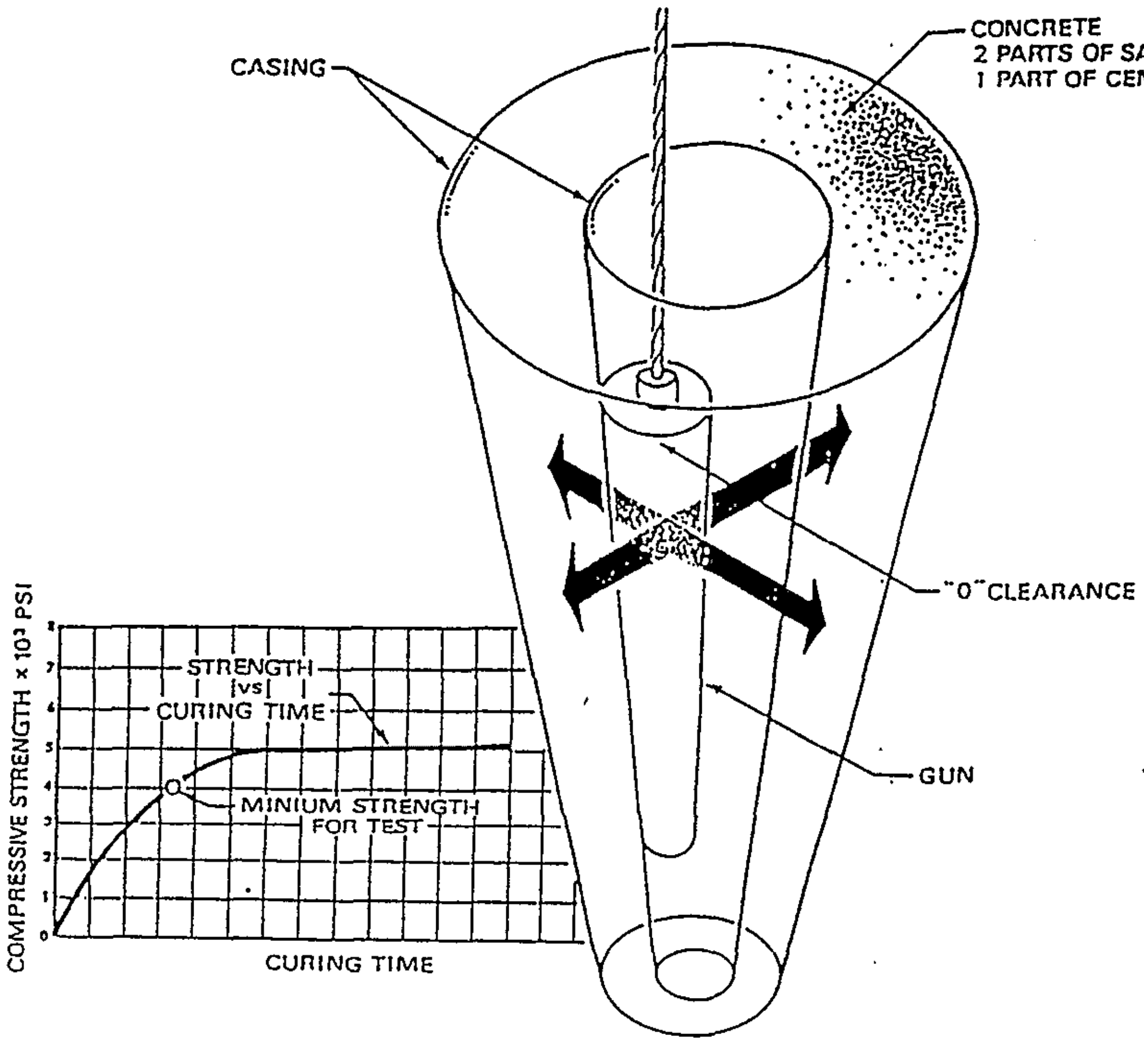
REVERSE PRESSURE PERFORATING



The above figure illustrates the results obtained by creating a favorable pressure differential in the well bore at the time of shooting. The initial pressure surge starts flow through all perforations. All holes now have an opportunities to be cleaned up simultaneously which reduces the chances for permanent plugging.

This technique permits a compatible fluid, such as nitrogen or diesel, to be used in the hole during the perforating procedure. This type completion enhances the efficiency of the well by reducing the possibility of permanently plugging some of the perforations.

TEST TARGET API-RP-43 SECTION I



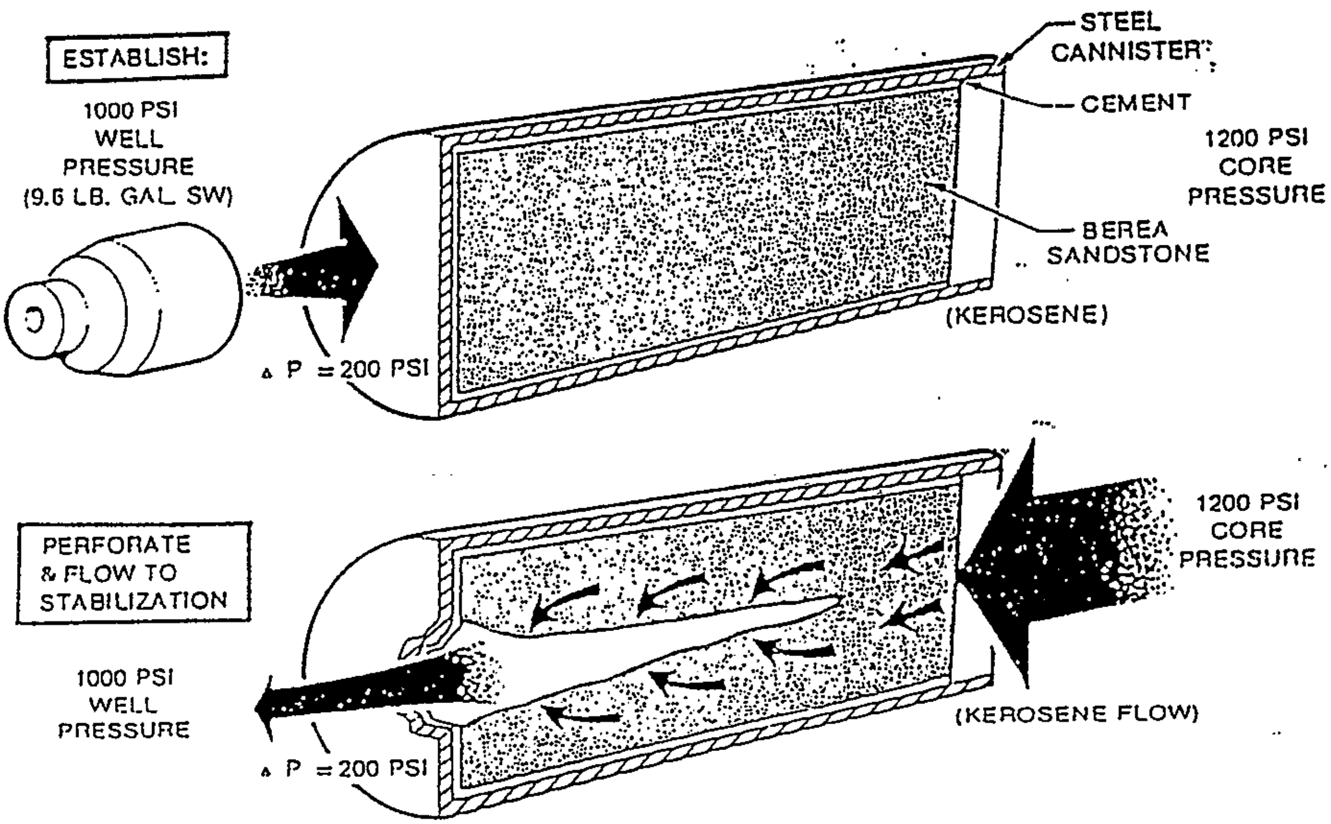
The API-RP-43 SECTION I test procedure is used to determine the physical characteristics of perforations under multiple-shot, atmospheric conditions. Six shots in their normal phasing and density configurations are used for each test. The Section I test is used for both casing and thru-tubing guns.

The target used is J-55 grade tubing or casing which is surrounded by a concrete sheath of a standard cement mixture. The concrete must cure for 28 days and have a minimum compressive strength of 4,000 pounds per square inch. Data obtained from the Section I test includes:

- PENETRATON -- the range in inches, including all six shots, measured from the original wall of the casing of tubing.
- HOLE DIAMETER - the average minimum lengths of the short and long elliptical axis measured 90° angles with a caliper.
- BURR HEIGHT - the maximum protrusion from the original pipe wall.
- DEPTH OF DEBRIS - the distance from the original inside of the pipe to the portion of the debris closest to the pipe wall.

It is recommended that the API Section I test be used only to evaluate the hole diameter and burr height for each type charge because the wide variations of concrete compressive strengths causes other parameter measurements to be unreliable.

REVERSE PRESSURE FLOW TEST PROCEDURE



The Section II test conditions for thru-tubing guns are slightly different. The charges are detonated while there is a differential pressure into the pipe. This time the saltwater in the well chamber is held at 1,000 psi while the kerosene in the target core is set at 1,200 psi. The test target is perforated and the core is flowed to stabilization while maintaining 1,200 psi of kerosene flow. Data obtained from the Section II test includes:

- EFFECTIVE PERMEABILITY
- CORE FLOW EFFICIENCY (CFE)
- TOTAL TARGET PENETRATION (TTP)
- TOTAL CORE PENETRATION (TCP)
- EFFECTIVE CORE PENTRATION (ECP) -- equal to CFE times TCP

It is recommended that the API Section II test be used to compare and evaluate the penetration and efficiency for each charge type.

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APPENDIX B

REQUEST FOR HANFORD SITE USE OF CLASS C EXPLOSIVES

CORRESPONDENCE DISTRIBUTION COVERSHEET

Author	Addressee	Correspondence No.
D. J. Moak, 6-2312	R. A. Holten, RL	9353335D

Subject: REQUEST FOR HANFORD SITE USE OF CLASS C EXPLOSIVES

INTERNAL DISTRIBUTION

Approval	Date	Name	Location	W/att
		Correspondence Control	A3-01	X
		President's Office	B3-01	
		B. G. Baker	L6-30	X
X		J. W. Bombino	L4-04	X
X		D. E. Good	S3-97	X
X		V. G. Heiman	S2-46	X
		H. E. McGuire	B3-63	X
X		D. J. Moak	N3-05	X
X		W. H. Price	N3-05	X
X		M. A. Tredway	R3-54	X
X		R. D. Wojtasek	H6-27	X
X		J. F. Woods	G4-07	X
		EDMC	H6-08	X

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April 21, 1993

9353335D

Mr. R. A. Holten, Director
Quality, Safety, and Health
Programs Division
U.S. Department of Energy
Richland Operations Office
Richland, Washington 99352

Dear Mr. Holten:

REQUEST FOR HANFORD SITE USE OF CLASS C EXPLOSIVES

Westinghouse Hanford Company (WHC) is requesting permission to bring on to the Hanford Site a well casing perforating technique which utilizes Class C explosives. This technique is required for the remediation and decommissioning of existing Resource Protection Wells (RPWs). Well construction of some wells dictate the use of shaped charge, jet-shot perforating techniques to install required surface seal and comply with Washington Administrative Codes 173-160-415 for the decommissioning of RPWs.

Jet-shot perforating of well casings is a standard technique used in oil and gas exploration. Use of this procedure has been monitored by the Occupational Safety and Health Administration and the U.S. Department of Alcohol, Tobacco and Firearms and safety procedures have been established. Provided in enclosure are detailed responses to questions posed in the Security Manual, WHC-CM-4-33, Section 2.13, "Control and Use of Explosives."

WHC recognizes a need for the use of jet-shot perforating over the next several years, therefore, we are requesting a one-time review and concurrence to allow for the uninterrupted access of perforating contractors to the site on an as needed basis, with the understanding that proper notification will be given prior to site entry. The initial workscope for this technique is the decommissioning of a Z-20 crib well as a required precursor to the restart of the Plutonium Finishing Plant. The total workscope for this technique is presently undetermined and will be addressed on a case-by-case basis as decommissioning is needed for wells across the site.

Mr. R. A. Holten
Page 2
April 21, 1993

9353335D

WHC requests written permission from your division prior to bringing contractors onto the Hanford Site. Please respond by May 10, 1993, so that procurement action may be initiated.

If you need more information, please call me at 376-7000, or Mr. D. J. Moak, of my staff, at 376-2312.

Very truly yours,

R. D. Wojtasek, Manager
Environmental Division

lgj

Enclosure

RL - R. L. Nelson
P. M. Pak
R. O. Puthoff (w/o enclosure)
R. P. Saget
J. L. Spracklen

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9353335D
ENCLOSURE
Page 1 of 3

WHC-CM-4-33, Section 4.2, CONTROL AND USE OF EXPLOSIVES, requires detailed responses to the following items:

1. Description and justification for proposed use, including specific locations(s) where explosives will be used.

   RESPONSE: All wells scheduled for jet-shot perforation are multiple casing string wells necessitating use of this technique for complete penetration into the formation. Charges needed (depending on total shots desired) will be loaded into a 6-inch perforating tool which is lowered into the wellbore by wireline to the desired depth. The charges are electrically detonated and the tool is withdrawn.

2. Kind and quantity of explosives and detonators to be used.

   RESPONSE: Caps and charges are Compound Rdx.

3. Maximum quantity of explosives and detonators to be on-site at any one time.

   RESPONSE: Maximum quantity on-site is 10 lbs.

4. Maximum quantity of explosives to be detonated instantaneously or used at any one time.

   RESPONSE: Maximum shots-40 jet-shots = 10 lbs.

5. Period of time for which approval is requested.

   RESPONSE: WHC expects to use jet-shot perforating on an as needed basis through the end of physical year 1998.

6. Safety codes and standards to be followed (see standards 4.2.9).

   RESPONSE: WHC will prepare a Site specific Safety Assessment Plan on case by case basis. The vendor will provide safety standards which will be reviewed by WHC prior to entering site. Safety codes and standards will be followed as addressed in WHC-CM-4-3, Industrial Safety Standards, Explosives Safety and the following DOE-RL prescribed (mandatory) standards for the use of explosives:

   a. Chapter 296-52 WAC - "WASHINGTON STATE SAFETY STANDARDS FOR THE POSSESSION AND HANDLING OF EXPLOSIVES"

   b. 29 CFR 1910.109 - EXPLOSIVES AND BLASTING AGENTS

1

c. 29 CFR 1926.900 thru 914 - BLASTING AND THE USE OF EXPLOSIVES

d. Department of Transportation (DOT) Regulation:

(1) 14 CFR Part 103 - AIR TRANSPORTATION

(2) 46 CFR Parts 146-149 - WATER CARRIERS

(3) 49 CFR Parts 171-179 - HIGHWAYS AND RAILWAYS

(4) 40 CFR Parts 390-397 - MOTOR CARRIERS

7. Person responsible for explosives activities must be a Washington State licensed blaster.

RESPONSE: The perforating contractor will provide a Washington State licensed blaster.

8. Storage facilities to be used, (if explosives/detonators are to be stored on-site). (Magazines must comply with standards for explosives storage with separation/compatibility requirements.)

RESPONSE: Detonating caps and charges will be carried in two separated magazines by two separate vehicles. Magazines are in compliance with Federal Alcohol, Tobacco and Firearms standards. Charges will not be stored on the Hanford Site.

9. Description of method employed to prohibit unauthorized personnel entry to area(s) where explosives are being handled/detonated, and method used to warn personnel of impending detonation(s).

RESPONSE: Controlled zones will be set up to deny access to unauthorized personnel entry as stated in the site-specific safety document for each project. Warning of impending detonation will done according to 29 CFR 1926.909. WHC will provide a responsible person from the Water Well Services Group for project direction. (FTL, Cognizant Engineer or Designee)

10. Type of conveyance to be used for transport of explosives.

RESPONSE: Perforating contractors will provide vehicles for the transport of the explosive material. WHC will provide adequate notification to Hanford Patrol for escort of the explosive materials. Transportation of explosive material will be done at times other than shift change.

11. Procedure for removal of unused explosives and detonators.

    RESPONSE: Non-detonated jet-shots will be removed as per the contractor's normal procedure with only essential personnel in zone.

12. Names of personnel needing prohibited articles passes.

    RESPONSE: As a contractor is chosen, the names of personnel needing prohibited article passes will be given to Security.

13. Names of persons authorized access to explosives magazines.

    RESPONSE: As a contractor is chosen, the names of personnel needing prohibited article passes will be given to Security.

14. Procedure for notification of nearby facility/utility landlords, immediately prior to detonation.

    RESPONSE: Due to the small charge and the operation being below surface, notification of the facility/utility landlords prior to detonation would not be necessary.

15. Procedure for control of radio frequency hazards.

    RESPONSE: Prior to loading the perforating gun, all vehicle radios and telephones will be shut-off.

16. A current running inventory of the contents of each storage magazine will be kept including each entry and withdrawal.

    RESPONSE: The perforating company will be responsible for keeping a running inventory of each magazine entry and withdrawal.

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To	From	Page 1 of 1
Distribution	M.G. Gardner	Date 06/01/93
Project Title/Work Order		EDT No. N/A
Jet-Shot Perforating Technique for Well Remediation/Abandonment		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
M. G. Gardner	N3-06	X			
V. G. Johnson	H6-06	X			
A. J. Knepp	H6-06	X			
R. R. Lehrschall	H4-67	X			
D. J. Moak	N3-05	X			
S. S. Narbutovskih	H6-06	X			
W. H. Price	N3-06	X			
K. D. Reynolds	H6-06	X			
W. V. Setzer	N3-05	X			
M. A. Tredway	P8-18	X			
B. G. Tuttle	N3-06	X			
R. D. Wojtasek	H6-27	X			
E. L. Wright	A5-19	X			
MGG LB	N3-06	X			

A-6000-135 (01/93) WEF067

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MEETING MINUTES

Subject: Use of Jet Shot perforating technique for well abandonment.

TO: Distribution BUILDING: See list

FROM: M. G. Gardner MG CHAIRMAN: M. G. Gardner

Dept-Operation-Component	Area	Shift	Meeting Date	Number Attending
Environmental	3000		05/27/93	12

Attendees:

C.S. Cline	Ecology	A.J. Knepp	WHC
P.S. Innis	EPA	R.R. Lehrschall	WHC
W. Staubitz	USGS	S.S. Narbutovskih	WHC
E.L. Wright	DOE/RL	K.D. Reynolds	WHC
M.G. Gardner	WHC	W.V. Setzer	WHC
V.G. Johnson	WHC	B.G. Tuttle	WHC

9312975.1885

This meeting was held to present information regarding the use of the jet-shot perforating technique in the abandonment of wells on the Hanford site. A letter requesting DOE/RL authorization for the utilization of this technique on site has been submitted by WHC. This authorization is required as the technique utilizes Class C explosives. Information regarding this request was forwarded by the DOE to regulatory agencies for comment. Although the Ecology agrees with the decision to perforate wells with the jet-shot, the EPA and USGS expressed some concerns. The intent of this meeting was to answer questions and address concerns regarding the technique and safety aspects of its use.

Mr. Gardner began the meeting with a brief explanation of the programmatic requirements for using the technique to abandon wells, when and why it would be required to be utilized, and the project for which the technique is currently being requested. Mr. Reynolds presented background information on the history of the technique. Ms. Narbutovskih presented technical information regarding the energy produced by the jet-shot and the potential for damage to adjacent structures (see attachment). Mr. Setzer described in detail and provided literature on the operation of the jet-shot.

A discussion followed in which questions and concerns were addressed. Calculations regarding the energy wave produced by the technique were discussed as well as data from subsurface explosive activities currently being conducted in the site seismic program. It was stated that once a vendor has been chosen, a vendor safety plan will be made available and a safety assessment can be conducted. Mr. Lehrschall indicated a safety assessment could be completed by mid July if the vendor's safety information was made available within 3-4 weeks.

All concerns expressed were satisfactorily addressed and all in attendance agreed the technique was appropriate for the intended use. The representatives from the Ecology, EPA, and USGS concurred with the proposed use of the jet-shot technique on the condition that safety and the impact on adjacent facilities be reviewed on a well by well basis. Mr. Gardner explained that Ecology's concurrence was required prior to conducting well remediation or abandonment and that the use of this technique would be evaluated thoroughly when required for perforating the well structure. A safety assessment would be conducted and required safety documentation prepared on a well by well basis or for a group of wells.

Based on this concurrence from the regulators, Mr. Wright agreed to recommend the DOE/RL approve the use of the jet-shot technique on the Hanford site. He indicated that he would submit a letter to the DOE the week of May 31, 1993 and WHC should have written authorization to proceed with the procurement for jet-shot perforating services by the week of June 5, 1993.

Generation And Attenuation of Seismic Energy at the 200 West Area

Recent concerns on the jet-shot perforating technique have addressed the issue of possible damage to nearby man-made structures. Although this issue can be addressed in various ways, there are three easy avenues: 1) body versus shear wave generation 2) frequency content and 3) energy dissipation. During an earthquake the most destructive energy travels as a surface wave along the free surface of the earth. An equivalent type of wave generated by man-made sources is the ground roll which is excited when the ground is impacted with a sledge hammer or a shallow dynamite charge. However since the jetgun is fired at depths below the surface of 140 to 200 feet, it is not possible to generate appreciable ground roll and thus, destruction from surface waves should not be an issue. Next concerns the frequency content of the source and propagating energy. In general earthquake frequencies are very low with high amplitudes while man-generated sources display very high frequencies with relatively low amplitudes or displacements. The frequencies associated with impulsive sources will generally have wavelengths of tens of feet while those from natural source be will on the order of hundreds of feet, an order of magnitude difference.

The final consideration involves the dissipation or attenuation of energy as the wave propagates through the earth. This attenuation depends on the frequency and velocity of the acoustic wave, the distance over which it is propagated and the ability of the subsurface material to propagate acoustic energy. This last parameter is described by the attenuation factor, Q. From data collected at the 300 areas with a source gun similar to the jetgun, calculations show that the amplitude of a ground roll generated at the surface will decrease by approximately 49 dB at 500 feet from jetgun which is the distance the gun is from a structure 450 feet from the borehole. The associated energy decreases by 50% for every 6 dB of attenuation and thus the energy loss is over 99% This evaluation assumes a medium with a homogeneous Q and does not account for reflected or refracted energy which would never arrive near the surface. Thus even less energy will be propagated. For a shallow, buried structure located at a horizontal distance of 450 feet, the jetgun source becomes a non-issue with respect to structural damage.

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WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 299-W18-19 — TEMPORARY WELL NO: ____
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 38,503 E/W W 76,403
Driller's Name: J. Bultena	WA State Lic Nr: Not documented	State Coordinates: N 443,609 E 2,218,823
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA	Start Card #: Not documented T____ R____ S____
Date Started: 25May82	Date Complete: 28Jun82	Elevation Ground surface (ft): Not documented

Depth to water: ND Jun82
(Ground surface) 197.8-ft 05Feb91

DIGRAMMATIC BOREHOLE
REMEDIATION/DECOMMISSIONING
PLAN (Depths are from ground surface)

[1] Place sand plug, 195-198-ft inside screen. Place ~2-ft bentonite crumbles/pellets, 193-195-ft.

[2] Perforate 6 and 8-in casings, 140-185-ft.
[2a] Run Sea-Mist for CCl4 detection.

[3] Set 6-in packer @150-ft. Pressure grout w/neat cement 140-193-ft. Allow 2-3 well volumes or pressure at surface not to exceed ~50psi on pump gage. Remove packer, wait on cement and tag.

[4] Perforate 6 and 8-in casing, 130-140-ft.
[4a] Run Sea-Mist for CCl4 detection.

[5] Set 6-in packer @ 120-ft. Pressure grout w/neat cement 130-140-ft as [3] above.

[6] Perforate 6 and 8-in casing, 125-130-ft.
[6a] Run Sea-Mist for CCl4 detection.

[7] Set 6-in packer @ 125-ft. Pressure grout w/neat cement 125-130-ft as [3] above.

[8] Perforate 6 and 8-in casing, 100-125-ft.
[8a] Run Sea-Mist for CCl4 detection. Check for perched water.

HOLD POINT:
[9] If water or CCL4 vapors are present, complete well as a monitoring/vapor extraction well. OR:

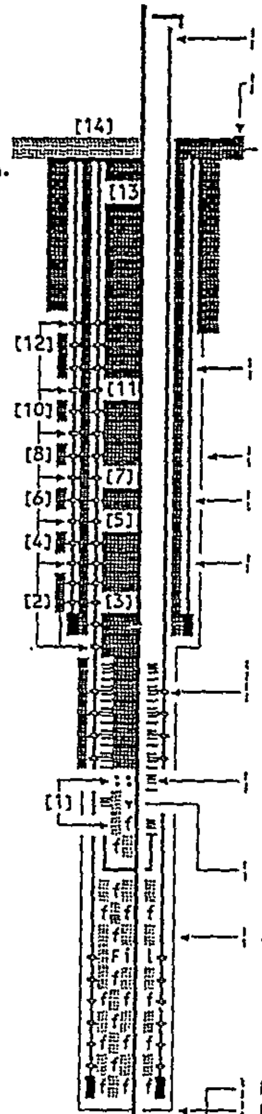
[10] Perforate 6 and 8-in casing, 60-100-ft.
[10a] Run Sea-Mist for CCL4 detection.

[11] Set 6-in packer @ 60-ft. Pressure grout w/neat cement 60-100-ft as [3] above.

[12] Perforate 6 and 8-in casing, 20-60-ft.
[12a] Run Sea-Mist for CCL4 detection.

[13] Set 6-in packer @ 3-ft. Pressure grout w/neat cement 3-60-ft as [3] above.

[14] Remove pad and surface seal to 3-ft. Cut casing @ 3-ft, top with cement if necessary and fill to grade.



- Elevation of reference point: (top of casing) [ND]
- Height of reference point above ground surface: [2.53-ft]
- Depth of surface seal [20-ft]
- Type of surface seal: Portland #2 cement to 20-ft
- I.D. of surface casing (If present) Pulled [10-in]
- I.D. of riser pipe: [6 & 8-in]
- Type of riser pipe: Carbon steel
- Diameter of borehole; 0-178-ft [9-in nom]
- Type of filler: Not documented
- Elevation/depth top of seal
- Type of seal: Not documented
- Depth top of perforations: [185-ft]
- Description of perforations: 185-195-ft, 4 cuts/rd/2 rds ft; 220-250-ft, 4 cuts/rd/ft
- 6-in telescoping screen 175-205 # 10 slot with packer and 5-ft extension with plate on bottom
- Depth to bottom, 198.9-ft 05Feb91
- Diameter of borehole; 178-250-ft [7-in nom]
- Depth bottom of perforations:
- Depth bottom of borehole: [250-ft]
- Depth bottom of 6-in casing:

Drawing By: RKL/2W18-19.PLN Date: 01Jun93

Reference: HANFORD WELLS

NOTE: Screen not removed to minimize creation of solid waste.

APPENDIX C

SOIL COLUMN INVENTORY FOR WELL 299-W18-19

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[1] From: Vernon G Johnson at ~WHC241 6/23/93 12:04PM (2005 bytes: 30 ln)
To: John A Locklair at ~WHC210
cc: Noel R Kerr at ~WHC210, Randall K Price at ~WHC302
Subject: JET SHOT WELL 299-W18-19
------------------------------ Message Contents ------------------------------

We do not have any soil/sediment data from analysis of cuttings obtained at the time the well was installed. However, records show that a total of about 3 Ci of americium-241 plus plutonium-239 was discharged to the crib. Shallow borings through the center of the crib confirm this estimate and suggest that nearly all the inventory is in the first 5 meters of the soil column beneath the crib. (Maximum TRU concentration was approximately 1500 pCi/g). Spectral gamma logs of the deeper intervals of the subject well are consistent with the above interpretation (based on 1990 RLS results, R. Price).

Based on the above, essentially all of the soil column contaminant inventory should be at a very shallow depth or at least confined to the upper 10 meters of the soil column beneath the crib. Chemical waste consisted primarily of either nitric acid or sodium hydroxide, the latter of which probably accounts for the gelatinous precipitate observed in the shallow soil column samples that were analyzed for Am and Pu as noted above.

The RLS log did not show any evidence of TRU. Thus contamination due to preferential flow of water and contaminants down along the outside of the unsealed casing was ruled out in previous evaluations.

In conclusion, available data suggest it is highly unlikely that contaminants will be encountered, dislodged or dispersed as a result of the proposed Jet shot work.

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DISTRIBUTION SHEET

To:	From:	Date:
Distribution	J. A. Locklair	July 26, 1993

Project Title/Work Order:

Safety Assessment for Environmental Investigations and Site Characterizations
Volume 3: Aggregate Safety Assessment for Installing Groundwater Monitoring Wells

EDT No.: ECN No.: 189912

Name	MSIN	With Attachment	EDT/ECN & Comment	EDT/ECN Only
M. R. Adams	H6-01	X		
J. R. Bell	R3-09	X		
T. L. Bennington	H4-16	X		
J. A. Bultena	N3-06	X		
R. A. Carlson	H6-03	X		
J. A. Charboneau	S3-10	X		
J. J. Dorian	H6-30	X		
K. R. Fecht	H6-06	X		
D. J. Foucault	S2-50	X		
R. P. Henckel	H6-02	X		
L. C. Hulstrom	H6-03	X		
N. R. Kerr	H4-67	X		
J. A. Locklair (2)	H4-67			
D. J. Moak	N3-05	X		
W. H. Price	N3-05			
K. A. Smith	N1-06	X		
W. R. Thackaberry	H4-16	X		
D. S. Takasumi	L4-93	X		
M. A. Tredway	R3-54	X		
B. A. Williams	H6-06	X		
T. M. Wintczak	H6-27	X		
J. J. Zimmer	H4-67	X		
Central Files (2 + original)	L8-04	X		
Dockett Files (2)	H5-36	X		
ERSS File (3)	H4-67	X		
EDMC (2)	H6-08	X		